PATENT APPLICATION
Docket No. 5038-293 (P12515X)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Andrew T. Wilson

Serial No.: 10/684,167

Examiner: Jeffrey Donels

Filed: October 10, 2003

Group Art Unit: 2837

Confirmation No.: 2311

For: PORTABLE HAND-HELD MUSIC SYNTHESIZER AND NETWORKING METHOD AND APPARATUS

Date: June 7, 2007

Mail Stop Appeal Brief – Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPEAL BRIEF

This Appeal Brief is in furtherance of the Notice of Appeal filed March 28, 2007. Applicant appeals the final rejection of claims 11-15 and 27-30.

REAL PARTY IN INTEREST

The present application has been assigned to the following party:

Intel Corporation
2200 Mission College Boulevard
P.O. Box 58119
Santa Clara, CA 95052-8119

RELATED APPEALS AND INTERFERENCES

The Board's decision in the present Appeal will not directly affect, or be directly affected, or have any bearing on any other appeals or interferences known to the appellant, or to the Applicant's legal representative.

STATUS OF CLAIMS

Claims pending in the application: 11-15 and 27-30.

Claims allowed: none

Claims canceled: 1-10, 16-26 and 31

Claims rejected: 11-15 and 27-30.

Claims appealed: 11-15 and 27-30.

STATUS OF AMENDMENTS

An Amendment After Final Rejection was filed on February 26, 2007 and a Supplemental Amendment After Final Rejection was filed on March 27, 2007. Both amendments were entered by the Examiner.

SUMMARY OF CLAIMED SUBJECT MATTER

Claim 11 is drawn to a plurality of musical apparatus communicating with each other. Figure 4 illustrates an exemplary embodiment where, for example, a plurality of musical devices 10' communicates with each other. <u>At least two</u> of the plurality of musical devices includes an audio score synthesis mechanism, an audio score <u>mixing mechanism</u>, and an audio score input mechanism to create a playable audio score (e.g., specification, page 6, line 31 - page 7, line 16; and page 13, lines 1-4).

Claim 27 is drawn to a plurality of portable musical apparatus (e.g., 10' of Figure 4) coupled through a wireless network, where <u>each</u> of the musical apparatus includes an audio score synthesis mechanism, an audio playing mechanism, an audio input mechanism, and an audio score <u>mixing mechanism</u> (e.g., specification, page 6, line 31-page 7, line 16; and page 13, lines 1-4). The mixing mechanism may mix a first audio score from the synthesis mechanism with a second audio score from the input mechanism to produce a playable audio score.

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Whether claims 11-15 and 27-30 are unpatentable under 35 U.S.C. 103(a) as being obvious over Ito (U.S. Patent Publication No. 2003/0121401) in view of Sitrick (U.S. Patent No. 6,084,168).

ARGUMENT

Claim Rejections – 35 USC §103

Claims 11-15 and 27-30 are rejected under 35 U.S.C. §103(a) as being obvious over Ito in view of Sitrick. Applicants traverse the rejection.

Claims 27 and 11

claim 27 recites *plural portable musical apparatus in physically separated proximity with each other and capable of two-way communication therebetween of an audio score over said wireless network, each musical apparatus including: ... an audio score mixing mechanism*. Claim 11 includes similar limitations.

The Ito reference discloses a system in which only one apparatus on the network has a mixer. The Examiner acknowledges this in the final office action, but alleges that it would have been obvious to adapt the Ito/Sitrick combination so that each device would have a mixing mechanism, as it has been held that mere duplication of working parts does not constitute nonobviousness and refers to MPEP 2144.04. The Examiner has essentially extracted a "*per se*" rule of obviousness from *In re Harza*, 274 F.2d 669, 124 USPQ 378 (CCPA 1960), which is referred to in the relevant section of MPEP 2144.04. However, The Court Of Appeals For The Federal Circuit has held that the precedents do not establish any *per se* rules of obviousness, and that reliance on *per se* rules of obviousness is legally incorrect and must cease. *In re Ochiai*, 37 USPQ2d 1127, 1133 (CAFC 1995). Instead, section 103 requires a fact-intensive comparison of the claimed invention with the teachings of the prior art, as done below.

Ito Figure 1 discloses a mixer apparatus 40, which includes a mixer and is wirelessly coupled to a plurality of musical apparatus 10 to 30. The plurality of musical apparatus 10 to 30 lacks a mixing mechanism. Audio signals and MIDI data from music apparatus 10 to 30 are transmitted to mixer apparatus 40, where those are mixed to produce new music tones. Put

differently, Ito's mixer apparatus 40 mixes audio signals and MIDI data received from the plurality of musical apparatus 10, 20, and 30 to produce new music tones.

In contrast, claim 27 recites a plurality of portable musical apparatus, where each apparatus including an audio score mixing mechanism. For example, each of the musical devices 10' of Figure 4 may include an audio score mixing mechanism. Including a mixing mechanism in *each* of the musical apparatus makes possible novel and unobvious features having unexpected advantages over the prior art. Such a feature, for example, makes possible a real-time peer-to-peer musical jam session, a real-time peer-to-peer 'swarm,' or an ad-hoc musical jam session (specification, page 6, lines 19-20 and page 7, lines 10-12). Ito's system, in which only one musical apparatus includes a mixer, can not perform any such musical jam sessions. Nor does Ito provide any reason for creating an apparatus to accommodate such musical jam session.

Additionally, Ito's system needs only one mixer (mixer 40) to work effectively. Ito does not provide any reason to include a mixer in each of the plurality of musical apparatus 10 to 30, as only one mixer 40 is sufficient for Ito's system. The Supreme Court has recently held that while determining obviousness for a §103 rejection, it is "important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements" in the prior art to achieve the claimed invention and such a reasoning should be made explicit. *KSR Int'l Co. v. Teleflex, Inc.,* No 04-1350 (U.S. Apr. 30, 2007). The Examiner has not identified any motivation, suggestion, or reason in Ito or any other references to include a mixing mechanism in each of the plurality of musical apparatus. The rejection, thus, is based on an impermissible hindsight reconstruction using the Applicant's disclosure as a roadmap to achieve the claimed invention. Hence, a *prima facie* case of obviousness has not been established.

For at least these reasons, claims 11 and 27 should be allowed along with their associated dependent claims.

CONCLUSION

Applicant requests that the rejection of claims 11-15 and 27-30 be reversed.

Customer No. 20575

Respectfully submitted,

MARGER JOHNSON & McCOLLOM, P.C.

Joseph S. Makuch

Joseph S. Makuch
Reg. No. 39,286

MARGER JOHNSON & McCOLLOM, P.C.
210 SW Morrison Street, Suite 400
Portland, OR 97204
(503) 222-3613

CLAIMS APPENDIX

The following claims are involved in the appeal.

11. (Rejected) A system of music devices operatively coupled together, the system comprising:

plural apparatus in physical proximity with each other and capable of at least one-way communication therebetween of an audio score,

at least two such apparatus comprising:

an audio score synthesis mechanism including a playing mechanism for playing the synthesized audio score;

an audio score mixing mechanism coupled with said synthesis mechanism for mixing plural audio scores to produce another audio score having components of each of the plural audio scores; and

an audio score input mechanism coupled with said mixing mechanism to provide one or more input audio scores thereto for mixing with the synthesized and outplayed played audio score,

said synthesis mechanism, said mixing mechanism and said input mechanism being operable in real time to create a playable audio score having components of plural audio scores produced by said plural proximate apparatus.

12. (Rejected) The system of claim 11, wherein the audio score for transmitting by said transmit mechanism is in the form of digital data.

13. (Rejected) The system of claim 12, wherein the digital data is formatted in accordance with a musical instrument digital interface (MIDI) standard.

14. (Rejected) The system of claim 11, wherein said audio score synthesis mechanism of said at least two such apparatus further includes a playing mechanism for playing the synthesized audio score and further comprising at least another such apparatus operatively coupled with said at least two such apparatus, said at least another such apparatus comprising:

an audio score output playing mechanism; and

a transmit mechanism for wirelessly transmitting an audio score to said at least two such apparatus for mixing thereby;

wherein said at least another apparatus further comprises:

a second audio score synthesis mechanism operatively coupled with said output mechanism for synthesizing an audio score for transmitting by said transmit mechanism;

a second audio score mixing mechanism coupled with said second synthesis mechanism for mixing plural audio scores to produce another audio score having components of each of the plural audio scores; and

a second audio score input mechanism coupled with said second mixing mechanism to provide one or more input audio scores thereto for mixing with the synthesized and played audio score,

said second synthesis mechanism, said second mixing mechanism and said second input mechanism being operable in real time to create a playable audio score having components of plural audio scores produced by said plural proximate apparatus.

15. (Rejected) The network of claim 14 wherein at least one of said plural apparatus further comprises a controller configurable as a master controller and at least another of said plural apparatus further comprises a controller configurable as a slave controller wherein said master controller is capable of dictating a mode of operation of said network to said slave controller.

27. (Rejected) A musical system comprising:

a wireless network; and

plural portable musical apparatus in physically separated proximity with each other and capable of two-way communication therebetween of an audio score over said wireless network, each musical apparatus including:

an audio score synthesis mechanism;

an audio playing mechanism coupled with said network;

an audio input mechanism coupled with said network; and

an audio score mixing mechanism coupled with said synthesis mechanism, said input mechanism and said playing mechanism, said mixing mechanism configured to mix a first audio score from said synthesis mechanism with a second audio score from said input mechanism to produce in real time a playable audio score having components of each of the first and second audio scores.

28. (Rejected) The musical system of claim 27, wherein the playable audio score is in the form of digital data.

29. (Rejected) The musical system of claim 28, wherein the digital data is formatted in accordance with a musical instrument digital interface (MIDI) standard.

30. (Rejected) The musical system of claim 29, wherein said wireless network takes the form of a WiFi or Bluetooth network.

EVIDENCE APPENDIX

Copies of the following references are attached:

U.S. Patent Publication No. 2003/0121401 ("Ito")

U.S. Patent No. 6,084,168 ("Sitrick")

RELATED PROCEEDINGS APPENDIX

None.

US 20030121401A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2003/0121401 A1

Ito (43) Pub. Date: Jul. 3, 2003

(54) MIXER APPARATUS AND MUSIC APPARATUS CAPABLE OF COMMUNICATING WITH THE MIXER APPARATUS

(75) Inventor: **Mikio Ito**, Tianjin (CN)

Correspondence Address:
David L. Fehrman
Morrison & Foerster LLP
35th Floor
555 W. 5th Street
Los Angeles, CA 90013 (US)

(73) Assignee: **Yamaha Corporation**, Hamamatsu-shi (JP)

(21) Appl. No.: **10/306,561**

(22) Filed: **Nov. 27, 2002**

(30) **Foreign Application Priority Data**

Dec. 12, 2001 (JP) 2001-378872

Publication Classification

(51) **Int. Cl.**^{7} **G10H 1/08**; G10H 7/00

(52) **U.S. Cl.** **84/625**

(57) **ABSTRACT**

A plurality of music apparatus **10** to **30** such as an electronic musical instrument and a microphone apparatus are connected by wireless to a mixer apparatus **40.** A Bluetooth module is adopted as wireless communication means to construct a piconet with mixer apparatus **40** functioning as a master and music apparatus **10** to **30** functioning as slaves. Audio signals and MIDI data from music apparatus **10** to **30** are transmitted by wireless to mixer apparatus **40** through isosynchronous communication procedure using Bluetooth modules **11, 21, 31, 41.** In mixer apparatus **40,** with regard to the MIDI data, music tone signals based on the MIDI data are produced, whereafter the produced music tone signals and the aforesaid audio signals transmitted by wireless are mixed. Wiring by means of cables between a plurality of music apparatus and a mixer apparatus is abolished, thereby eliminating the cumbersomeness of wiring and the restrictions accompanying the wiring.

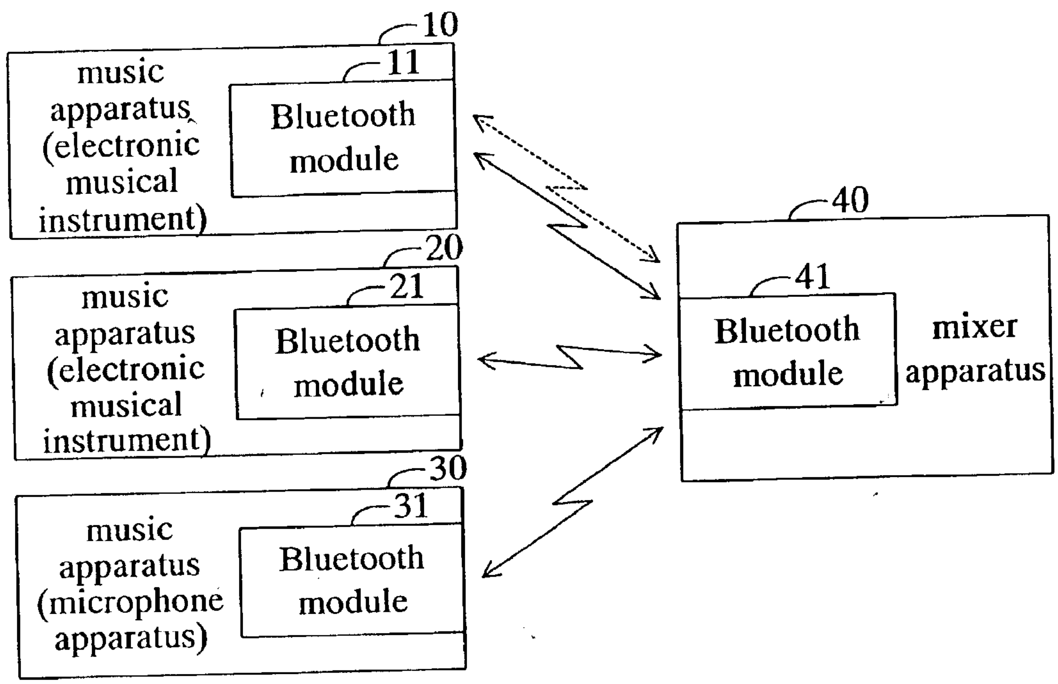
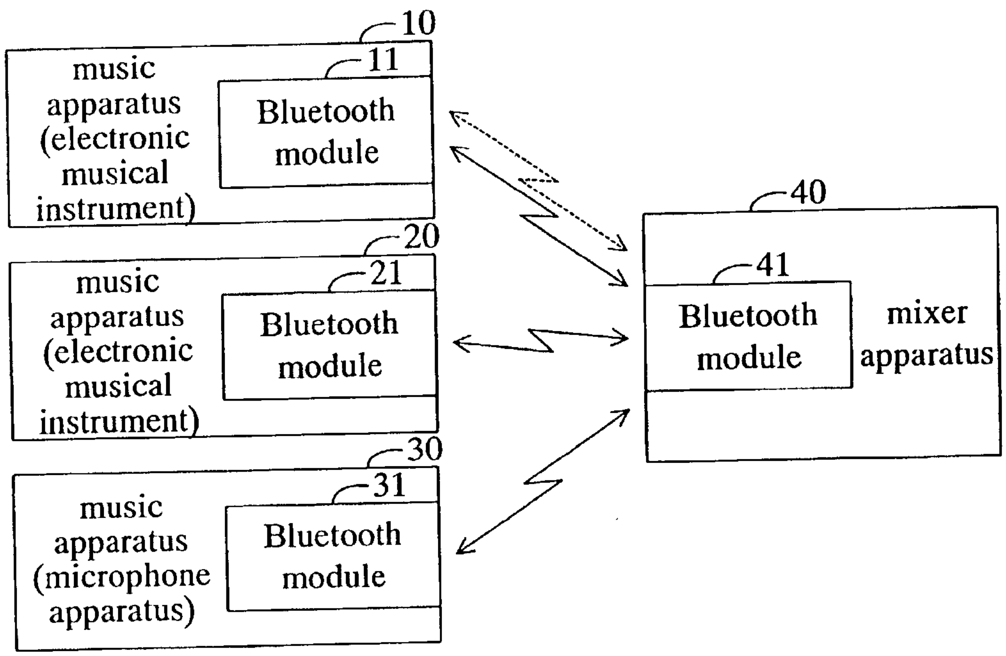


FIG.1



10
11
music apparatus (electronic musical instrument)
Bluetooth module
20
21
music apparatus (electronic musical instrument)
Bluetooth module
30
31
music apparatus (microphone apparatus)
Bluetooth module
40
41
Bluetooth module
mixer apparatus

FIG.2

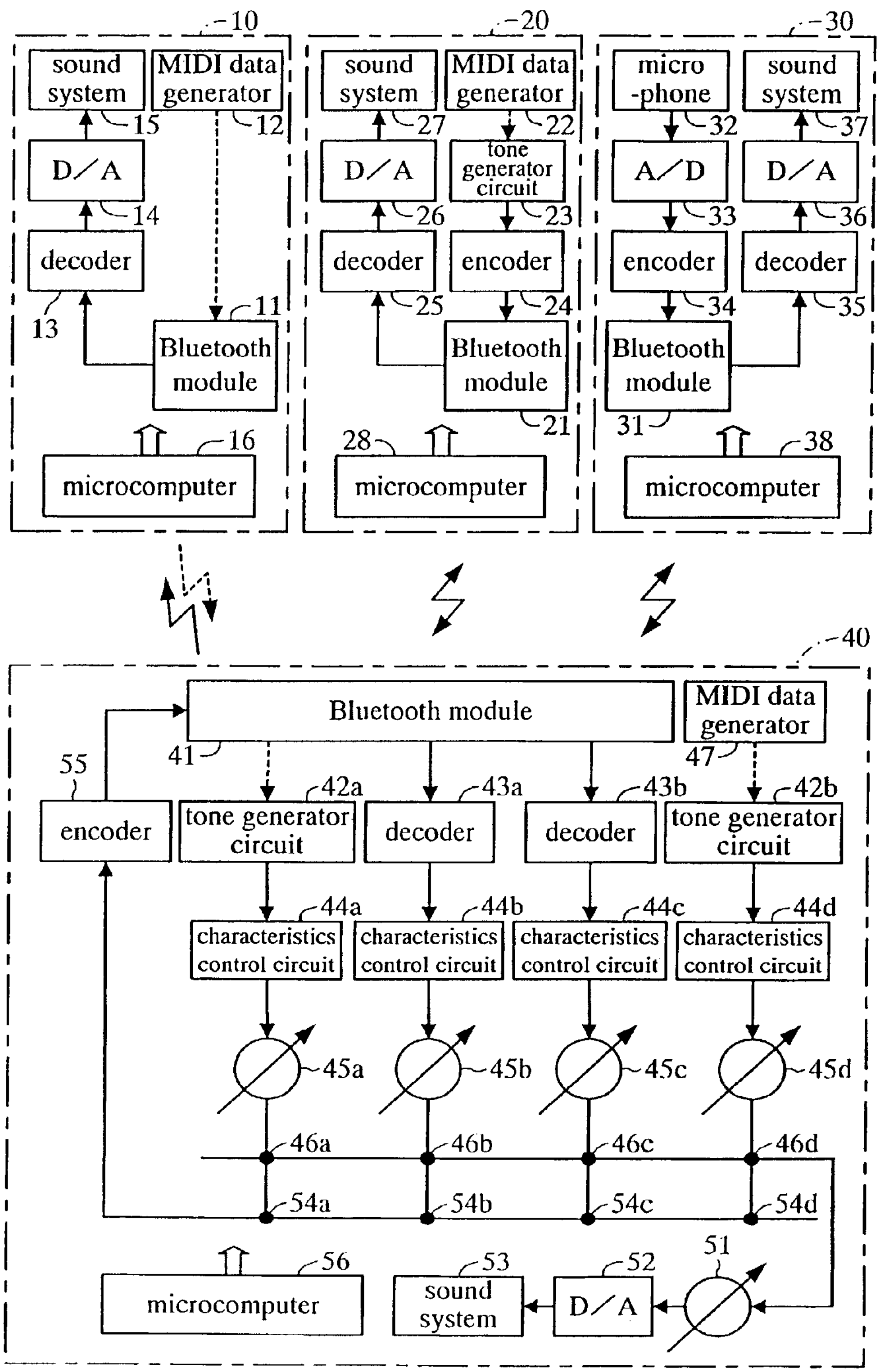

10
sound system
MIDI data generator
15
12
D/A
14
decoder
13
11
Bluetooth module
16
microcomputer
20
sound system
MIDI data generator
27
22
D/A
tone generator circuit
26
23
decoder
encoder
25
24
Bluetooth module
21
28
microcomputer
30
micro -phone
sound system
32
37
A/D
D/A
33
36
encoder
decoder
34
35
Bluetooth module
31
38
microcomputer
40
Bluetooth module
MIDI data generator
41
47
55
42a
43a
43b
42b
encoder
tone generator circuit
decoder
decoder
tone generator circuit
44a
44b
44c
44d
characteristics control circuit
characteristics control circuit
characteristics control circuit
characteristics control circuit
45a
45b
45c
45d
46a
46b
46c
46d
54a
54b
54c
54d
51
56
53
52
microcomputer
sound system
D/A

FIG.3

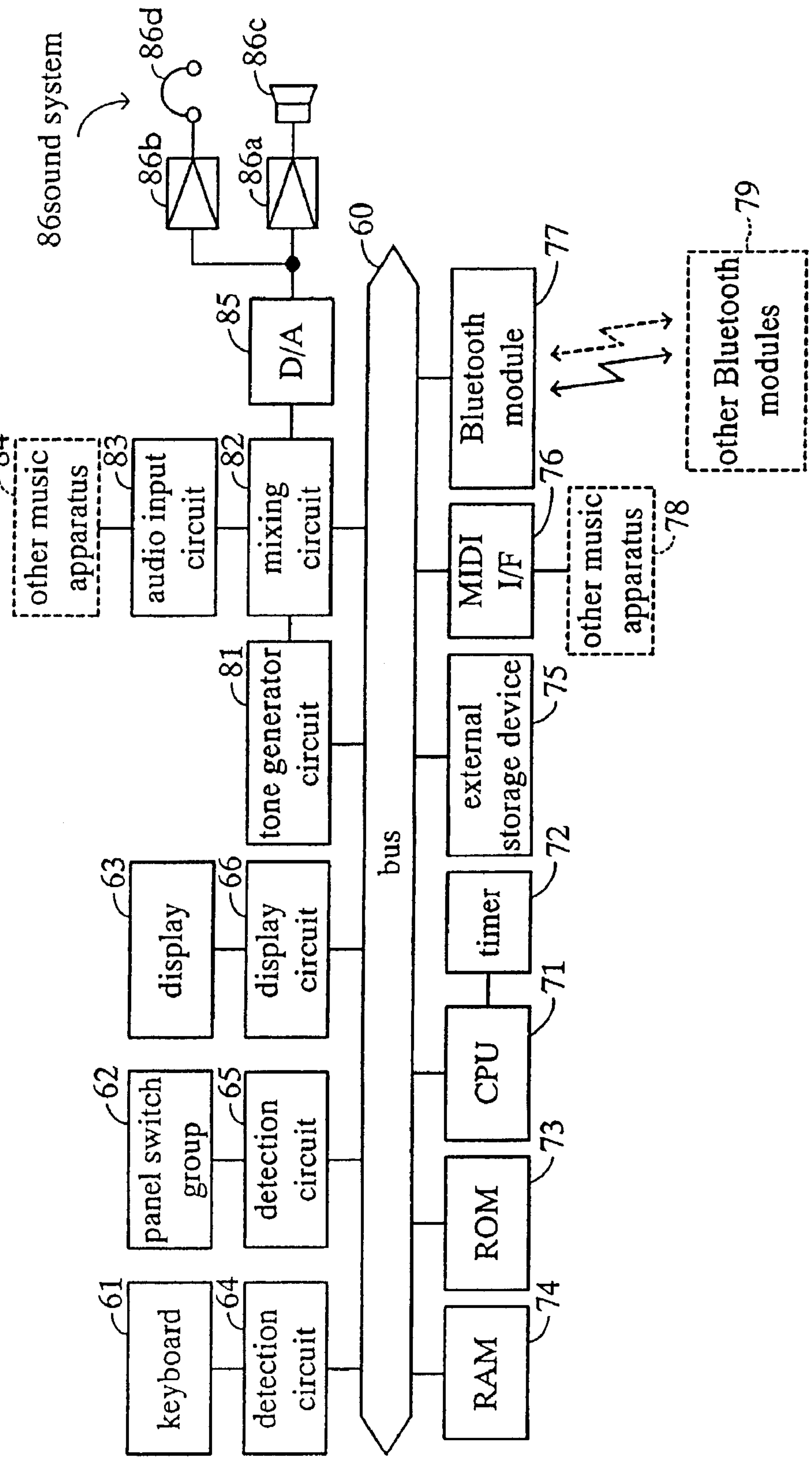

86sound system
86d
86c
86b
86a
60
77
79
85
D/A
84
83
82
other music apparatus
audio input circuit
mixing circuit
Bluetooth module
other Bluetooth modules
76
78
MIDI I/F
other music apparatus
81
tone generator circuit
external storage device
75
bus
63
66
display
display circuit
timer
72
71
CPU
62
65
panel switch group
detection circuit
ROM
73
61
64
keyboard
detection circuit
RAM
74

FIG.4

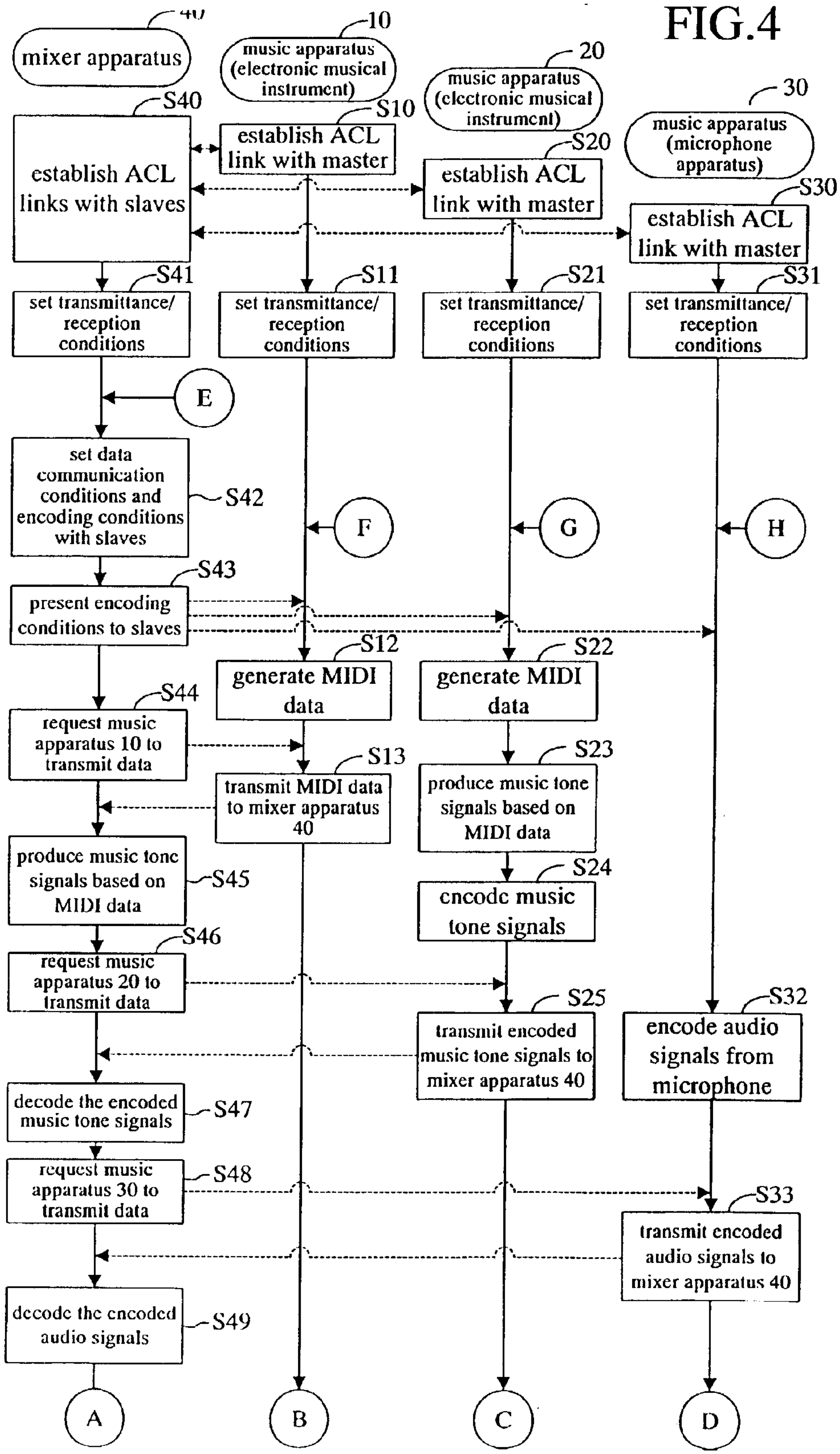
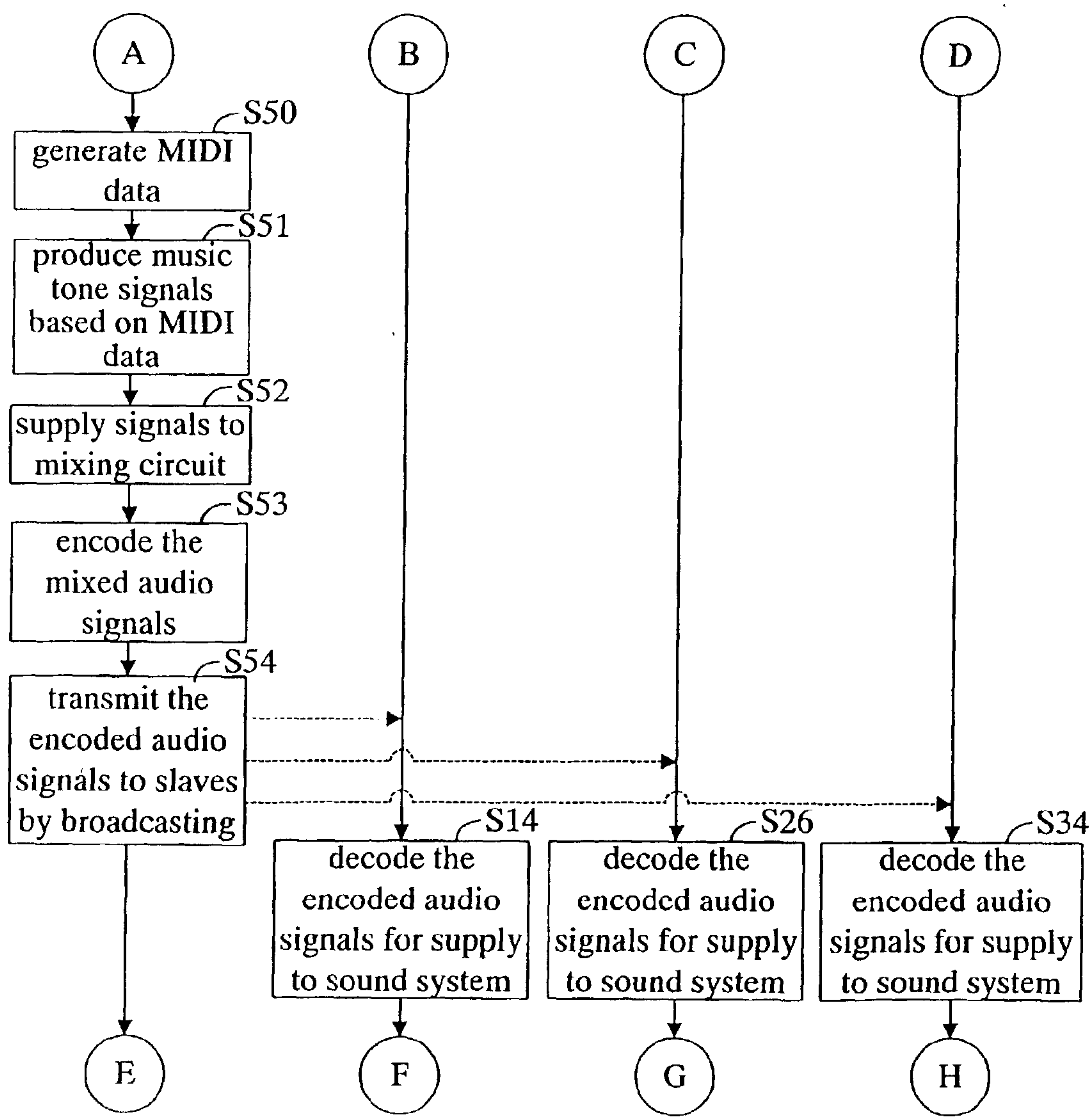

40
mixer apparatus
10
music apparatus (electronic musical instrument)
20
music apparatus (electronic musical instrument)
30
music apparatus (microphone apparatus)
S40
establish ACL links with slaves
S10
establish ACL link with master
S20
establish ACL link with master
S30
establish ACL link with master
S41
set transmittance/ reception conditions
S11
set transmittance/ reception conditions
S21
set transmittance/ reception conditions
S31
set transmittance/ reception conditions
E
set data communication conditions and encoding conditions with slaves
S42
F
G
H
S43
present encoding conditions to slaves
S12
generate MIDI data
S22
generate MIDI data
S44
request music apparatus 10 to transmit data
S13
transmit MIDI data to mixer apparatus 40
S23
produce music tone signals based on MIDI data
produce music tone signals based on MIDI data
S45
S24
encode music tone signals
S46
request music apparatus 20 to transmit data
S25
transmit encoded music tone signals to mixer apparatus 40
S32
encode audio signals from microphone
decode the encoded music tone signals
S47
request music apparatus 30 to transmit data
S48
S33
transmit encoded audio signals to mixer apparatus 40
decode the encoded audio signals
S49
A
B
C
D

FIG.5



A
B
C
D
S50
generate MIDI data
S51
produce music tone signals based on MIDI data
S52
supply signals to mixing circuit
S53
encode the mixed audio signals
S54
transmit the encoded audio signals to slaves by broadcasting
S14
decode the encoded audio signals for supply to sound system
S26
decode the encoded audio signals for supply to sound system
S34
decode the encoded audio signals for supply to sound system
E
F
G
H

MIXER APPARATUS AND MUSIC APPARATUS CAPABLE OF COMMUNICATING WITH THE MIXER APPARATUS

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a mixer apparatus for inputting audio signals or audio signal producing signals respectively produced in a plurality of music apparatus and for mixing the input audio signals or audio signals produced on the basis of the input audio signal producing signals, as well as a music apparatus capable of wireless communication with the mixer apparatus.

[0003] 2. Description of the Background Art

[0004] Hitherto, mixer apparatus for mixing audio signals from a plurality of music apparatus such as an electronic musical instrument and a microphone apparatus for output are well known.

[0005] However, the aforementioned conventional mixer apparatus are connected to the plurality of music apparatus by means of cables, giving rise to problems such as cumbersome wiring and connection of the cables and the restrictions imposed by the cables on the placement of the music apparatus and the mixer apparatus.

SUMMARY OF THE INVENTION

[0006] The present invention has been made in order to cope with the aforementioned problems of the prior art, and an object thereof is to provide a mixer apparatus for inputting audio signals or audio signal producing signals from a plurality of music apparatus by wireless without the use of cables and for mixing the input audio signals or audio signals produced on the basis of the input audio signal producing signals. Another object of the present invention is to provide a music apparatus capable of wireless communication with a mixer apparatus such as mentioned above and a computer readable program applied to the mixer apparatus.

[0007] In order to achieve the aforementioned objects, a characteristic feature of the present invention lies in a mixer apparatus for inputting audio signals or audio signal producing signals respectively produced in a plurality of music apparatus and for mixing the input audio signals or audio signals produced on the basis of the input audio signal producing signals, said mixer apparatus comprising a wireless communication section capable of wireless communication with the plurality of music apparatus by allowing the plurality of music apparatus to function as slaves and allowing the mixer apparatus itself to function as a master, said wireless communication section respectively receiving the audio signals or audio signal producing signals that are transmitted from the plurality of music apparatus; and a mixing section for mixing the audio signals received by the wireless communication section or the audio signals produced on the basis of the audio signal producing signals received by the wireless communication section.

[0008] In this case, the wireless communication section respectively issues requests to the plurality of music apparatus for transmittance of the audio signals or audio signal producing signals, and respectively receives the audio signals or audio signal producing signals that are transmitted from the plurality of music apparatus in response to the requests for transmittance Further, as means for wireless communication between the plurality of music apparatus and the mixer apparatus, one can use, for example, a wireless communication device according to the Bluetooth (registered trademark) standard. Further, when audio signal producing signals are transmitted from the music apparatus to the mixer apparatus, audio signals may be produced in an audio signal producing section comprised within the mixing section on the basis of the audio signal producing signals, and the produced audio signals may be mixed.

[0009] According to this feature, the audio signals or the audio signal producing signals from the plurality of music apparatus are supplied to the mixer apparatus by wireless, thereby eliminating the need for connecting the plurality of music apparatus to the mixer apparatus by means of cables. This saves the labor of wiring and connection of the cables, and the placement of the music apparatus and the mixer apparatus can be made freely without being restricted by the cables. Further, since the mixer apparatus inputs the audio signals or the audio signal producing signals from a plurality of music apparatus, traffic (transfer of information) can be controlled efficiently by allowing the mixer apparatus to function as a master and allowing the plurality of music apparatus to function as slaves.

[0010] Further, another characteristic feature of the present invention lies in that the wireless communication section receives the audio signals or audio signal producing signals from the plurality of music apparatus by isochronous communication procedure. In this case, isochronous communication (isochronous transfer) procedure makes use of an ACL link (asynchronous connection-less link). This feature allows that, if the number of music apparatus is small, the audio signals or the audio signal producing signals can be sent at a comparatively high transfer rate, so that the communication can be made with comparatively less delays.

[0011] Further, another characteristic feature of the present invention lies in that the mixer apparatus further comprises mixed signal transmitting section for transmitting the audio signals mixed in the mixing section to the plurality of music apparatus via the aforesaid wireless communication section. According to this feature, the results of mixing the plurality of audio signals are sent to each music apparatus by wireless, so that the aforesaid results of mixing can be monitored at the position of each music apparatus.

[0012] Further, another characteristic feature of the present invention lies in that the aforesaid wireless communication section transmits the audio signals mixed in the mixing section to the plurality of music apparatus by broadcast communication procedure (multiple address communication procedure). According to this feature, the results of mixing a plurality of audio signals are transmitted by broadcast communication, so that the traffic can be controlled efficiently without increasing the traffic amount.

[0013] Further, another characteristic feature of the present invention lies in that the mixer apparatus further comprises communication condition setting section for setting conditions of communication with the plurality of music apparatus in a state in which a wireless connection is established between the mixer apparatus and the plurality of music apparatus. In this case, the communication conditions

are, for example, selection of the type of music apparatus from which the audio signals or audio signal producing signals are to be input into the mixer apparatus, selection of the type of signals (audio signals or audio signal producing signals) which are to be supplied from the music apparatus to the mixer apparatus, and selection of the music apparatus to which the results of mixing the plurality of audio signals are to be output. This feature allows that, even if the combination of a plurality of music apparatus supplied to the mixer apparatus is changed, one can meet the change speedily.

[0014] Further, another characteristic feature of the present invention lies in that the mixer apparatus comprises wired input section connected by wire to a different music apparatus other than the plurality of music apparatus, for wired input of audio signals or audio signal producing signals for producing audio signals that are output from the different music apparatus, wherein the aforesaid mixing section also mixes the audio signals input by the wired input section or the audio signals produced on the basis of the audio signal producing signals input by the wired input section, in addition to the audio signals received by the wireless communication section or the audio signals produced on the basis of the audio signal producing signals received by the wireless communication section.

[0015] This feature allows that, even if a music apparatus incapable of wireless communication with the mixer apparatus is present, the music apparatus can be connected by wire to the mixer apparatus, whereby audio signals from this music apparatus connected by wire or the audio signals produced on the basis of the audio signal producing signals from this music apparatus can be mixed as well by the mixer apparatus. As a result of this, this mixer apparatus can be applied to a variety of music apparatus.

[0016] Further, another characteristic feature of the present invention lies in that the mixer apparatus further comprises audio signal generating section for generating audio signal independently from the aforesaid plurality of music apparatus, wherein the aforesaid mixing section also mixes the audio signals generated by the audio signal generating section, in addition to the audio signals received by the wireless communication section or the audio signals produced on the basis of the audio signal producing signals received by the wireless communication section. According to this feature, more audio signals can be mixed, whereby a more opulent music can be realized.

[0017] Further, another characteristic feature of the present invention lies in a music apparatus capable of wireless communication with a mixer apparatus that mixes a plurality of audio signals, wherein the music apparatus comprises mixing signal generating section for generating the audio signals that will be subjected to mixing or audio signal producing signals for producing the audio signals that will be subjected to mixing; a wireless communication section for transmitting by wireless to the mixer apparatus the audio signals or the audio signal producing signals generated by the mixing signal generating section and for receiving mixed signals mixed by the mixer apparatus and transmitted by wireless from the mixer apparatus, said mixed signals including the audio signals transmitted by wireless from the music apparatus or the audio signals produced on the basis of the audio signal producing signals transmitted by wireless from the music apparatus; and reproduction section for reproducing the audio signals received by the wireless communication section.

[0018] In this case as well, as means for wireless communication between the music apparatus and the mixer apparatus, one can use, for example, a wireless communication device according to the Bluetooth standard. Further, when audio signal producing signals are transmitted from the music apparatus to the mixer apparatus, audio signals may be produced in an audio signal producing section comprised within the mixing section on the basis of the audio signal producing signals, and the produced audio signals may be mixed.

[0019] This feature as well eliminates the need for connecting the music apparatus to the mixer apparatus by means of cables, and saves the labor of wiring and connection of the cables. Also, the placement of the music apparatus and the mixer apparatus can be made freely without being restricted by the cables. Furthermore, since the music apparatus inputs and reproduces the results of mixing the plurality of audio signals in the mixer apparatus, the aforesaid results of mixing can be monitored at the position of the music apparatus.

[0020] Further, another characteristic feature of the present invention lies in a computer readable program that is applied to a mixing apparatus and music apparatus for allowing the mixing apparatus and music apparatus to perform the aforementioned functions. According to this feature, the aforementioned various functions can be implemented easily by the mixing apparatus and music apparatus having a wireless communication function.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] **FIG. 1** is a block diagram illustrating a network according to one embodiment of the present invention;

[0022] **FIG. 2** is a functional block diagram illustrating the network of **FIG. 1** in further detail;

[0023] **FIG. 3** is a block diagram illustrating an embodiment of a music apparatus (electronic musical instrument) and a mixer apparatus of **FIGS. 1 and 2**;

[0024] **FIG. 4** is a flowchart showing the former part of a program executed by the mixer apparatus and the music apparatus of **FIGS. 1 and 2** and related to link setting and data transmission/reception; and

[0025] **FIG. 5** is a flowchart showing the latter part of the program.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0026] Hereafter, one embodiment of the present invention will be described with reference to the attached drawings. **FIG. 1** is a block diagram illustrating a network according to this embodiment.

[0027] This network is constituted with a plurality of music apparatus **10** to **30** and a mixer apparatus **40** respectively capable of wireless communication with these music apparatus **10** to **30**. Music apparatus **10** to **30** produce audio signals such as music tone signals or produce audio signal producing signals (for example, MIDI data) such as key-on

signals, key-off signals, tone color control signals, and tone volume control signals that are used for production of these audio signals. Mixer apparatus **40** inputs audio signals or audio signal producing signals from plural music apparatus **10** to **30**, and mixes the audio signals or audio signals produced on the basis of the audio signal producing signals for output.

[0028] These music apparatus **10** to **30** and mixer apparatus **40** respectively include, as a wireless communication section, Bluetooth (registered trademark) modules **11, 21, 31, 41** that allows wireless communication with each other in accordance with the Bluetooth communication standard. The wireless communication according to the Bluetooth communication standard provides data exchange between plural apparatus with the use of a spectrum diffusion procedure of frequency hopping type. Further, in the wireless communication using this Bluetooth communication standard, a wireless network called "piconet" is constructed which is made of one master and one or more slaves, where Bluetooth modules belonging to one and the same piconet are in a synchronized state with each other in the frequency axis and in the time axis.

[0029] Further, in the Bluetooth communication standard, one of two types of communication links, which are an SCO (synchronous connection-oriented) link and an ACL (asynchronous connection-less) link, is selected for use in accordance with a setting. Furthermore, the communication in this ACL link is set to use one procedure selected from the asynchronous communication procedure, the isochronous communication (isochronous transfer) procedure, and the broadcast communication procedure (multiple address communication procedure).

[0030] Here, among the above-described characteristics of the Bluetooth communication standard, this embodiment is characterized by adopting a piconet construction including one master and plural slaves as well as the isochronous communication procedure and the broadcast communication procedure in the ACL link. Various wireless communication techniques conforming to a communication standard having the aforesaid characteristics can be applied to the present invention even if the techniques do not conform to the Bluetooth communication standard.

[0031] The aforesaid network of **FIG. 1** will be further detailed using the functional block diagram of **FIG. 2** by raising specific examples of music apparatus **10** to **30**. Here, the illustrated arrows drawn in solid lines denote audio signals and the illustrated arrows drawn in broken lines denote MIDI data.

[0032] Music apparatus **10** is constituted with an electronic musical instrument and produces MIDI data for output. This music apparatus **10** is provided with a MIDI data generator **12** that generates MIDI data, and the MIDI data generated by MIDI data generator **12** are transmitted by wireless to mixer apparatus **40** by Bluetooth module **11**. On the other hand, the audio signals transmitted by wireless from mixer apparatus **40** are received by Bluetooth module **11** and supplied to sound system **15** via decoder **13** and D/A converter **14**. Decoder **13** decodes (decompresses) the audio signals that are encoded (compressed) by mixer apparatus **40** and outputs the decoded audio signals. Further, music apparatus **10** includes a microcomputer **16**, and microcomputer **16** performs various functions in music apparatus **10** by a program process.

[0033] Music apparatus **20** also is constituted with an electronic musical instrument and produces and outputs digital music tone signals (audio signals). This music apparatus **20** is provided with a MIDI data generator **22** that generates MIDI data and a tone generator circuit **23** that produces and outputs digital music tone signals (audio signals) on the basis of the aforesaid generated MIDI data. These digital music tone signals are encoded (compressed) by encoder **24** and transmitted by wireless to mixer apparatus **40** by Bluetooth module **21**. On the other hand, the audio signals transmitted by wireless from mixer apparatus **40** are received by Bluetooth module **21** and supplied to sound system **27** via decoder **25** and D/A converter **26**. Decoder **25** decodes (decompresses) and outputs the audio signals that are encoded (compressed) by mixer apparatus **40** as well. Further, in this case as well, music apparatus **20** includes a microcomputer **28**, and microcomputer **28** performs various functions in music apparatus **20** by a program process.

[0034] Music apparatus **30** is constituted with a microphone apparatus and is provided with a microphone **32** that converts acoustic signals such as human voices and tones of musical instruments into audio signals by acoustic/electric conversion for output. These audio signals converted by microphone **32** are converted into digital audio signals by A/D converter **33**. These converted digital audio signals are encoded (compressed) by encoder **34** and transmitted by wireless to mixer apparatus **40** by Bluetooth module **31**. On the other hand, the audio signals transmitted by wireless from mixer apparatus **40** are received by Bluetooth module **31** and supplied to sound system **37** via decoder **35** and D/A converter **36**. Decoder **35** decodes (decompresses) and outputs the audio signals that are encoded (compressed) by mixer apparatus **40** as well. Further, in this case as well, music apparatus **30** includes a microcomputer **38**, and microcomputer **38** performs various functions in music apparatus **30** by a program process.

[0035] Mixer apparatus **40** is provided with a Bluetooth module **41** that receives the MIDI data, digital music tone signals, and digital audio signals respectively transmitted by wireless from music apparatus **10** to **30**. These received MIDI data, digital music tone signals, and digital audio signals are respectively output to tone generator circuit **42*a***, decoder **43*a***, and decoder **43*b***, respectively. Tone generator circuit **42*a*** produces and outputs digital music tone signals (one type of audio signals) on the basis of the MIDI data. Decoders **43*a***, **43*b*** decode (decompress) and output the digital music tone signals and digital audio signals respectively encoded (compressed) by music apparatus **20, 30**.

[0036] Characteristics control circuits **44*a*** to **44*c*** are respectively connected to tone generator circuit **42*a*** and decoders **43*a***, **43*b***. Characteristics control circuits **44*a*** to **44*c*** respectively perform a compressing process, a limiting process, an equalizing process, and the like on the supplied digital music tone signals and digital audio signals for output. The compressing process is a process of changing the dynamic range of the input signals. The limiting process is a process of restraining the maximum level of the input signals. The equalizing process is a process of changing the frequency characteristics of the input signals.

[0037] Level setting circuits **45*a*** to **45*c*** are connected to respective outputs of characteristics control circuits **44*a*** to

44*c*. Level setting circuits **45***a* to **45***c* change the input signal levels in various ways for output. The outputs of level setting circuits **45***a* to **45***c* are input into additive synthesis circuits **46***a* to **46***c*. Additive synthesis circuits **46***a* to **46***c* are each provided with a gate circuit that selectively outputs the signals from level setting circuits **45***a* to **45***c*, and the results of addition from the additive synthesis circuit of the previous stage (additive synthesis circuit located on the illustrated left side) are added to the signals selectively output from the aforesaid gate circuit and output to the additive synthesis circuit of the following stage (additive synthesis circuit located on the illustrated right side).

[0038] Further, mixer apparatus **40** is provided with a MIDI data generator **47** that outputs MIDI data independently with no relation to the outside music apparatus **10** to **30** and a tone generator circuit **42***b* that produces and outputs digital music tone signals (one type of audio signals) on the basis of the aforesaid generated MIDI data. The digital music tone signals output from tone generator circuit **42***b* are output to additive synthesis circuit **46***d* via characteristics control circuit **44***d* and level setting circuit **45***d* that are constructed in the same manner as the aforesaid characteristics control circuits **44***a* to **44***c* and level setting circuits **45***a* to **45***c*.

[0039] The output from additive synthesis circuit **46***d* of the final stage is input into level setting circuit **51**. Level setting circuit **51** changes the input signal levels in various ways for output. The output of level setting circuit **51** is connected to sound system **53** via D/A converter **52** that converts digital signals to analog signals.

[0040] The respective outputs of level setting circuits **45***a* to **45***d* are also connected to additive synthesis circuits **54***a* to **54***d* that are constructed in the same manner as the aforesaid additive synthesis circuits **46***a* to **46***d*. Here, in additive synthesis circuits **54***a* to **54***d*, the additive synthesis circuit of the previous stage corresponds to the one located on the illustrated right side, and the additive synthesis circuit of the following stage corresponds to the one located on the illustrated left side. The output from additive synthesis circuit **54***a* of the final stage is encoded (compressed) by encoder **55** and respectively output to music apparatus **10** to **30** via Bluetooth module **41**. Furthermore, mixer apparatus **40** includes a microcomputer **56**, and microcomputer **56** performs various functions in mixer apparatus **40** by a program process.

[0041] Next, one embodiment of the electronic musical instruments used as the aforesaid music apparatus **10, 20** and a mixer apparatus of electronic musical instrument function incorporating type used as mixer apparatus **40** will be described with reference to **FIG. 3**.

[0042] The apparatus of this type is provided with a keyboard **61** made of a plurality of keys, a panel operator group **62** disposed on an operation panel, and a display **63**. Each key indicates the generation of a music tone signal, and the pressing/depressing of each key is detected by a detection circuit **64** connected to bus **60**. Panel switch group **62** is operated mainly in relation to the display on display **63**, and selects or controls various functions in this apparatus, such as the music tone elements (pitch shift, tone color, tone volume, and the like) of the generated music tone signals, the effects imparted to the music tone signals, the state of mixing a plurality of music tone signals, the generation of automatic accompaniment tones, and the reproduction of automatic play tones. These operations of panel operator group **62** are detected by a detection circuit **65** connected to bus **60**. Display **63** displays symbols, characters, and the like for selecting and setting various functions in this apparatus under control of a display circuit **66** connected to bus **60**.

[0043] Also, a CPU **71**, a timer **72**, a ROM **73**, a RAM **74**, and an external storage device **75** are connected to bus **60**. CPU **71** executes various programs including the programs shown in **FIGS. 4 and 5** stored in ROM **73**, RAM **74**, or external storage device **75** in collaboration with timer **72** and RAM **74**, thereby realizing various functions of this apparatus. External storage device **34** includes recording media having a comparatively large capacity such as a hard disk HD, a flexible disk FD, a compact disk CD, a magneto-optical disk MO, a digital versatile disk DVD, and a semiconductor memory, as well as a drive unit for each of the recording media. These recording media store various programs as well as various data used for implementing various functions of this apparatus, such as, various control data for producing music tone signals and for controlling the produced music tone signals, and control data for controlling the generation of music tone signals (automatic performance data made of MIDI data).

[0044] Also, a MIDI interface circuit **76** and a Bluetooth module **77** are connected to bus **60**. MIDI interface circuit **76** inputs MIDI data from other music apparatus **78** such as electronic musical instruments and sequencers connected by wire, and outputs MIDI data to the aforesaid other music apparatus **78**. Bluetooth module **77** receives audio signals and MIDI data from Bluetooth modules **79** incorporated in other music apparatus such as electronic musical instruments, sequencers, and microphone apparatus connected by wireless, and transmits audio signals and MIDI data to Bluetooth modules **79** incorporated in the aforesaid other music apparatus.

[0045] Also, a tone generator circuit **81** and a mixing circuit **82** are connected to bus **60**. Tone generator circuit **81** produces music tone signals in accordance with the control signals (MIDI data) input via bus **60** and representing key-on, key-off, and others for output to mixing circuit **82**. In this case, the aforesaid control signals (MIDI data) are supplied by performance operations on keyboard **61** and reproduction of music data stored in external storage device **75** by automatic play. Further, MIDI data supplied from other MIDI apparatus **78** to MIDI interface circuit **76** by wire and MIDI data supplied from other Bluetooth modules **79** to Bluetooth module **77** by wireless are supplied to tone generator circuit **81** via bus **60**.

[0046] Mixing circuit **82** inputs digital music tone signals of plural series supplied from tone generator circuit **81** through channels that are different series by series, and mixes the plural music tone signals after controlling the characteristics and levels of the music tone signals for each channel. Also, an audio input circuit **83** connected by wire to other music apparatus **84** is connected to mixing circuit **82**. Audio input circuit **83** inputs audio signals from other music apparatus (electronic musical instruments, automatic play apparatus, microphone apparatus, and the like) by wire and outputs the audio signals to mixing circuit **82**. Also, audio signals transmitted by wireless from other Bluetooth modules **79** and received by Bluetooth module **77** are input

into mixing circuit **82** via bus **60**. Mixing circuit **82** respectively inputs the audio signals from audio input circuit **83** and Bluetooth module **77** as well through channels that are different from those of the aforesaid music tone signals, controls the characteristics and levels of the audio signals at each channel, and mixes the audio signals with the aforesaid digital music tone signals from tone generator circuit **81**.

[0047] The output of mixing circuit **82** is connected to D/A converter **85**. D/A converter **85** converts the digital audio signals from the mixing circuit into analog audio signals for output to sound system **86**. Sound system **86** is composed of amplifiers **86***a*, **86***b*, speaker **86***c*, and headphone **86***d*.

[0048] Here, the relationship of music apparatus **10**, **20** and mixer apparatus **40** in **FIG. 2** to the afore said music apparatus constructed as shown in **FIG. 3** will be described. First, the relationship between music apparatus **10** in **FIG. 2** and the music apparatus in **FIG. 3** will be described. MIDI data generator **12** in **FIG. 2** corresponds to a device for outputting the performance data produced by playing on keyboard **61** and a device for reproducing the performance data in the music data stored in external storage device **75** in **FIG. 3**. In other words, MIDI data generator **12** in **FIG. 2** corresponds to keyboard **61**, detection circuit **64**, CPU **71**, external storage device **75**, and others in **FIG. 3**. Bluetooth module **11**, D/A converter **14**, and sound system **15** in **FIG. 2** correspond to Bluetooth module **77**, D/A converter **85**, and sound system **86** in **FIG. 3**, respectively. Decoder **13** in **FIG. 2** corresponds to a device for decoding the audio signals received by Bluetooth module **77** by a program process, namely, to CPU **71**, RAM **74**, and others in **FIG. 3**. Microcomputer **16** in **FIG. 2** corresponds to CPU **71**, timer **72**, ROM **73**, RAM **74**, and external storage device **75** in **FIG. 3**.

[0049] The relationship between music apparatus **20** in **FIG. 2** and the music apparatus in **FIG. 3** will be described. MIDI data generator **12** in **FIG. 2** corresponds to a device for outputting the performance data produced by playing on keyboard **61**, a device for reproducing the performance data in the music data stored in external storage device **75**, a device for inputting MIDI data from outside, and others in **FIG. 3**, namely, to keyboard **61**, detection circuit **64**, CPU **71**, external storage device **75**, MIDI interface circuit **76**, Bluetooth module **77**, and others in **FIG. 3**. Tone generator circuit **23** in **FIG. 2** corresponds to a device for producing music tone signals in accordance with performance data, MIDI data, or the like, namely, to tone generator circuit **81** in **FIG. 3**. Regarding Bluetooth module **21**, decoder **25**, D/A converter **26**, sound system **27**, and microcomputer **28** in **FIG. 2**, the same applies as in the case of Bluetooth module **11**, decoder **13**, D/A converter **14**, sound system **15**, and microcomputer **16** in **FIG. 2** described above.

[0050] The relationship between mixer apparatus **40** in **FIG. 2** and the music apparatus in **FIG. 3** will be described. MIDI data generator **47** in **FIG. 2** corresponds to a device for outputting the performance data produced by playing on keyboard **61** and a device for reproducing the performance data in the music data stored in external storage device **75** in **FIG. 3**, namely, to keyboard **61**, detection circuit **64**, CPU **71**, external storage device **75**, and others in **FIG. 3**. Tone generator circuits **42***a*, **42***b* in **FIG. 2** correspond to a device for producing music tone signals in accordance with performance data, MIDI data, or the like, namely, to tone generator circuit **81** in **FIG. 3**. Decoders **43***a*, **43***b* in **FIG. 2** correspond to a device for decoding the audio signals received by Bluetooth module **77** by a program process, namely, to CPU **71**, RAM **74**, and others in **FIG. 3**. Encoder **55** in **FIG. 2** corresponds to a device for encoding the audio signals to be output to Bluetooth module **77** by a program process, namely, to CPU **71**, RAM **74**, and others in **FIG. 3**.

[0051] Characteristics control circuits **44***a* to **44***d*, level setting circuits **45***a* to **45***d*, **51**, additive synthesis circuits **46***a* to **46***d*, **54***a* to **54***d* correspond to a device for controlling the characteristics of audio signals by a program process, a device for controlling the levels of audio signals by a program process, and a device for performing additive synthesis of audio signals by a program process, namely, to panel switch group **62**, detection circuit **65**, CPU **71**, RAM **74**, mixing circuit **82**, and others. Bluetooth module **41**, D/A converter **52**, and sound system **53** in **FIG. 2** correspond to Bluetooth module **77**, D/A converter **85**, and sound system **86** in **FIG. 3**, respectively. Microcomputer **56** in **FIG. 2** corresponds to CPU **71**, timer **72**, ROM **73**, RAM **74**, and external storage device **75** in **FIG. 3**.

[0052] Further, although an embodiment of music apparatus (microphone apparatus) **30** in **FIG. 2** is not illustrated, sound system **37** in this music apparatus **30** corresponds to sound system **86** such as shown in **FIG. 3**, and includes a speaker and a headphone. Further, microcomputer **38** in **FIG. 2** is constructed with circuits similar to CPU **71**, timer **72**, ROM **73**, RAM **74**, and external storage device **75** in **FIG. 3**.

[0053] Next, the operation of music apparatus **10** to **30** and mixer apparatus **40** constructed as shown above will be described along the flowcharts of **FIGS. 4 and 5**. In these music apparatus **10** to **30** and mixer apparatus **40**, Bluetooth modules **11**, **21**, **31**, **41** of apparatus **10** to **40** are set in advance so that music apparatus **10** to **30** may function as slaves and mixer apparatus **40** may function as a master. When the power switches of apparatus **10** to **40** are turned on in a predetermined area music apparatus **10** to **40** can transmit and receive data with each other, an ACL link is established among Bluetooth modules **11**, **21**, **31**, **41**. Alternatively, when apparatus **10** to **40** are moved into a predetermined area in a state in which the power switches of apparatus **10** to **40** are turned on, an ACL link is established among Bluetooth modules **11**, **21**, **31**, **41**. In this case, the power switch of mixer apparatus **40** functioning as a master is turned on first, and thereafter the power switches of music apparatus **10** to **30** functioning as slaves are turned on (or the slaves are moved into an area where communication with the master can be made). This is because, if a Bluetooth module functioning as a master is not present, the piconet connection is not established. Thus, microcomputers **16**, **28**, **38**, **56** establish the aforesaid ACL link of Bluetooth modules **11**, **21**, **31**, **41** by the processes of steps **S10**, **S20**, **S30**, **S40**.

[0054] Next, conditions for transmitting and receiving signals between music apparatus **10** to **30** and mixer apparatus **40** are set. In this case, a user operates panel switch group **62** while looking at display **63** of music apparatus **10** to **30** and mixer apparatus **40**. Hereafter, the aforesaid setting of the conditions for transmitting and receiving signals will be described by referring to the above-described case of **FIG. 2** as an example. In mixer apparatus **40**, channels in

mixing, input sources, and types of input signals are set as a condition for receiving signals, as shown in the following Table 1, through the process of step **S41** performed by microcomputer **56**. Further, in the step **S41**, destinations for outputting the results of mixing shown in the following Table 2 are set as a condition for transmitting signals.

TABLE 1

Ch	input sources	type of input signals
1	music apparatus 10 (electronic musical instrument) (Bluetooth module 11)	MIDI
2	music apparatus 20 (electronic musical instrument) (Bluetooth module 21)	audio
3	music apparatus 30 (microphone)	audio
	(Bluetooth module 31)	MIDI
4	mixer apparatus 40	

[0055]

TABLE 2

mixing output destinations
music apparatus 10 (electronic musical instrument) (Bluetooth module 11)
music apparatus 20 (electronic musical instrument) (Bluetooth module 21)
music apparatus 30 (microphone) (Bluetooth module 31)

[0056] In music apparatus **10** to **30**, output destinations and types of output signals are set, as shown in the following Table 3, by the processes of steps **S11**, **S21**, **S31** performed by microcomputers **16**, **28**, **38** as a condition for transmitting signals. Further, in these processes of steps **S11**, **S21**, **S31**, monitor input sources shown in the following Table 4 are set as a condition for receiving signals.

TABLE 3

output destinations	types of output signals
mixer apparatus 40 (Bluetooth module 41)	MIDI

[0057]

TABLE 4

monitor input sources
mixer apparatus 40 (Bluetooth module 41)

[0058] After the aforesaid process of step **S41**, microcomputer **56** in step **S42** sets a condition for communicating data in accordance with the number of connected slaves, the types of transmitted and received signals (MIDI/audio signals), and others, and sets a condition for encoding the audio signals to be transmitted and received. Specifically, if the number of connected slaves is large, the quality of the audio signals at the time of encoding may be reduced (if the quality is low, the amount of data per one channel decreases, so that simultaneous transmittance/reception can be made through a larger number of channels), while if the number of slaves is small, the quality at the time of encoding the audio signals may be raised (if simultaneous transmission/reception is made through a smaller number of channels, the amount of data per one channel can be increased, so that the audio signals can be transmitted and received with raised quality of encoding). Alternatively, if MIDI is included as the transmitted and received signals, the quality of the audio signals at the time of encoding may be raised (since the amount of transmitted/received data is small in MIDI, the quality of the audio signals can be raised by allotting the reduced amount to the data transmittance/reception of the audio signals). In any case, the encoding condition is variably set so that the audio data can be transmitted and received with the highest possible quality in accordance with the number of connected slaves and the types of transmitted and received signals.

[0059] Then, in step **S43**, the encoding condition is transmitted to music apparatus **10** to **30** via Bluetooth module **41**. In music apparatus **10** to **30**, the aforesaid transmitted encoding condition is incorporated into microcomputers **16**, **28**, **38** via Bluetooth modules **11**, **21**, **31**, whereafter the decoding operations and encoding operations in decoders **13**, **25**, **35**, **43*a***, **43*b*** and encoders **24**, **34**, **55** will be controlled in accordance with the aforesaid encoding condition.

[0060] After the setting of various conditions such as described above is finished, when MIDI data are generated in MIDI data generator **12** through the process of step **S12** performed by microcomputer **16**, Bluetooth module **11** temporarily stores these MIDI data.

[0061] Further, in music apparatus **20**, when MIDI data are generated in MIDI data generator **22** through the process of step **S22** performed by microcomputer **28**, digital music tone signals are produced in tone generator circuit **23** on the basis of the aforesaid MIDI data by the process of step **S23**. These digital music tone signals are encoded in encoder **24** through the process of step **S24** and supplied to Bluetooth module **21**, which in turn temporarily stores the aforesaid encoded digital music tone signals.

[0062] Further, in music apparatus **30**, when audio signals such as human voices and tones of musical instruments are input into microphone **32**, these audio signals are subjected to A/D conversion in A/D converter **33**. These digital audio signals subjected to A/D conversion are then encoded in encoder **34** through the process of step **S32** performed by microcomputer **28** and supplied to Bluetooth module **31**, which in turn temporarily stores the aforesaid encoded digital music tone signals.

[0063] When a request for data transmittance is issued from mixer apparatus **40** to music apparatus **10** through the process of step **S44** performed by microcomputer **56** in this state, music apparatus **10** transmits the aforesaid MIDI data temporarily stored in Bluetooth module **11** to mixer apparatus **40** through the process of step **S13** performed by microcomputer 16. Mixer apparatus **40** receives these transmitted MIDI data at Bluetooth module **41**.

[0064] In mixer apparatus **40**, the MIDI data received at Bluetooth module **41** are sent to tone generator circuit **42*a***

through the process of step S45. Tone generator circuit **42***a* then produces digital music tone signals on the basis of these MIDI data.

[0065] Also, when a request for data transmittance is issued from mixer apparatus **40** to music apparatus **20** through the process of step S46 performed by microcomputer **56**, music apparatus **20** transmits the aforesaid encoded digital music tone signals temporarily stored in Bluetooth module **21** to mixer apparatus **40** through the process of step S25 performed by microcomputer **28**. Mixer apparatus **40** receives these transmitted digital music tone signals at Bluetooth module **41**. These music tone signals are then decoded in decoder **43***a* through the process of step S47.

[0066] Also, when a request for data transmittance is issued from mixer apparatus **40** to music apparatus **30** through the process of step S48 performed by microcomputer **56**, music apparatus **30** transmits the aforesaid encoded digital audio signals temporarily stored in Bluetooth module **31** to mixer apparatus **40** through the process of step S33 performed by microcomputer **38**. Mixer apparatus **40** receives these transmitted digital audio signals at Bluetooth module **41**. These digital audio signals are then decoded in decoder **43***b* through the process of step S49.

[0067] Further, in mixer apparatus **40**, when MIDI data are generated in MIDI generator **47** through the process of step S50 of **FIG. 5** performed by microcomputer **56**, digital music tone signals are produced in tone generator circuit **42***b* on the basis of the aforesaid MIDI data through the process of step S51.

[0068] Next, the aforesaid produced and decoded digital music tone signals and digital audio signals are supplied from tone generator circuits **42***a*, **42***b* and decoders **43***a*, **43***b* to characteristics control circuits **44***a* to **44***d* constituting the mixing circuit through the process of step S52. Characteristics control circuits **44***a* to **44***d* independently control the characteristics of the digital music tone signals and digital audio signals from tone generator circuit **42***a*, decoders **43***a*, **43***b*, and tone generator circuit **42***b*, respectively, for output to level setting circuits **45***a* to **45***d*, respectively. Level setting circuits **45***a* to **45***d* independently control the tone volume levels of the digital music tone signals and digital audio signals having controlled characteristics, respectively, for output to additive synthesis circuits **46***a* to **46***d*, respectively.

[0069] Additive synthesis circuits **46***a* to **46***d* perform additive synthesis of these digital music tone signals and digital audio signals, and output the synthesized digital audio signal to D/A converter **52** via level setting circuit **51**. D/A converter **52** in turn converts this digital audio signal into analog audio signal and supplies the converted analog audio signal to sound system **53**. Sound system **53** then generates the aforesaid analog audio signal.

[0070] On the other hand, the aforesaid digital music tone signals and digital audio signals from level setting circuits **45***a* to **45***d* are also supplied to additive synthesis circuits **54***a* to **54***d*, respectively, and additive synthesis circuits **54***a* to **54***d* perform additive synthesis of these digital music tone signals and digital audio signals for output.

[0071] Then, through the process of step S53 performed by microcomputer **56**, the aforesaid digital audio signal obtained by additive synthesis of the digital music tone signals and digital audio signals is encoded in encoder **55** and temporarily stored into Bluetooth module **41**. This digital audio signal temporarily stored in Bluetooth module **41** is transmitted from the module **41** to music apparatus **10** to **30** respectively by broadcast communication procedure (multiple address communication procedure) through the process of step S54.

[0072] Music apparatus **10** to **30** receive the aforesaid transmitted digital audio signal at Bluetooth modules **11** to **31**, respectively. Then, through the processes of steps S14, S26, S34 performed by microcomputers **16**, **28**, **38**, the aforesaid received digital audio signal is decoded in decoders **13**, **25**, **35**, respectively. These decoded digital audio signals are converted into analog audio signals in D/A converters **14**, **26**, **36**, respectively. These analog audio signals are then supplied to sound systems **15**, **27**, **37** for generating tones.

[0073] After the aforesaid processes of steps S14, S26, S34, S54, microcomputers **16**, **28**, **38**, **56** return to steps S12, S22, S32, S42, respectively, and repeatedly execute the aforesaid processes of steps S12, S22, S32, S42 to steps S14, S26, S34, S54, thereby continuously executing the aforesaid operation of mixing the audio signals.

[0074] As will be understood from the above description of the operations, according to the above-described embodiment, the audio signals (including the music tone signals) and MIDI data from the plurality of music apparatus **10** to **30** are supplied to mixer apparatus **40** by wireless, thereby eliminating the need for connecting the plurality of music apparatus **10** to **30** to mixer apparatus **40** by means of cables. This saves the labor of wiring and connection of the cables, and the placement (arrangement) of music apparatus **10** to **30** and mixer apparatus **40** can be made freely without being restricted by the cables.

[0075] Further, since mixer apparatus **40** inputs the audio signals and MIDI data from the plurality of music apparatus **10** to **30**, traffic (transfer of information) can be controlled efficiently by allowing mixer apparatus **40** to function as a master and allowing the plurality of music apparatus **10** to **30** to function as slaves. Specifically, in piconet connection of Bluetooth, transmittance and reception of data are always carried out through communication between a master and slaves. For this reason, supposing that data are to be transmitted from one slave to a different slave, one must once transmit the data from the one slave to the master and thereafter transmit the data from the master to the different slave. Supposing that the one slave is a music apparatus and the different slave is mixer apparatus **40**, the data transmitted from music apparatus **10** to **30** are once received by the master and thereafter transmitted from the master to mixer apparatus **40**. If this is carried out, one piece of data must be sent twice, thereby increasing the communication traffic and increasing the time delay till the piece of data reaches the destination. However, if mixer apparatus **40** is the master, data can be transmitted from music apparatus **10** to **30** functioning as slaves to mixer apparatus **40** by one data transmittance process, thereby preventing the increase of communication traffic and the increase of time delay.

[0076] Moreover, since mixer apparatus **40** is constructed to receive audio signals and MIDI data from the plurality of music apparatus **10** to **30** by isochronous communication

procedure, the audio signals and MIDI data can be transmitted at a comparatively high transfer rate, thereby achieving a communication with comparatively smaller delays. Specifically, in the piconet connection of Bluetooth, there are an SCO link and an ACL link, as described before. The SCO link is a communication link with three channels at the maximum which is suitable for real-time voice communication with a predetermined communication speed (64 kbps) ensured. On the other hand, the ACL link is a communication link which is originally unsuitable for voice communication with varying communication speed depending on data traffic and others. At first sight, the SCO link may seem suitable for mixer apparatus **40**; however, the ACL link can have seven channels at the maximum with a high maximum communication speed (for example, 432.6 kbps at the maximum), and can transmit audio data of high tone quality. Moreover, in the ACL link, there are the asynchronous communication procedure, the isochronous communication procedure, and the broadcast communication procedure, and among these, the isochronous communication procedure is a procedure with comparatively smaller time delays. Therefore, in this embodiment, mixer apparatus **40** having a comparatively high competence has been realized by adopting the isochronous communication procedure of the ACL link with comparatively smaller time delays at this communication speed. Here, if a high competence is not desired, mixer apparatus **40** with three channels at the maximum may be realized by adopting the SCO link.

[0077] Further, since music apparatus **10** to **30** receive and reproduce the audio signals mixed in mixer apparatus **40**, the results of mixing a plurality of audio signals can be monitored at the position of each music apparatus **10** to **30**. Since the transmittance of audio signals in this case is carried out by the broadcast communication procedure (multiple address communication procedure), the traffic can be controlled efficiently without increasing the amount of traffic. Specifically, with the broadcast communication procedure, the slave side that has received data need not send a response notifying the receipt of data to the master, and moreover, the same data can be transmitted to a plurality of slaves at a time, thereby enhancing the traffic efficiency. Here, since the slaves do not send the response notifying the receipt of data to the master, there will be no assurance of data reaching the destination with certainty; however, the loss of a small amount of data will not be a problem as long as the data are used for confirming the results of mixing. In this case, a filter for smoothing the data may be used in order to prevent noise generation caused by the loss of data.

[0078] Further, the communication condition such as described above between mixer apparatus **40** and music apparatus **10** to **30** is set through the processes of steps **S10**, **S11**, **S20**, **S21**, **S30**, **S31**, **S40**, **S41**. Therefore, even if the combination of mixer apparatus **40** with plural music apparatus **10** to **30** is changed, one can meet the change speedily.

[0079] Furthermore, although not specifically described in the above description of operations using the functional block diagram of **FIG. 2**, mixer apparatus **40** can receive input of audio signals also by wire from another music apparatus **84** into audio input circuit **83**, as shown in **FIG. 3**, and these audio signals can be mixed as well. Further, mixer apparatus **40** can receive input of MIDI data also by wire from another music apparatus **78**, as shown in **FIG. 3**, and the audio signals produced in tone generator circuit **81** on the basis of these MIDI data can be mixed as well. Therefore, audio signals and audio signals based on MIDI data from other music apparatus without having wireless communication means can be mixed as well in mixer apparatus **40**, whereby more audio signals can be mixed, and a more opulent music can be realized.

[0080] Here, in the above-described embodiment, three music apparatus **10** to **30** are connected to mixer apparatus **40**; however, the number of music apparatus connected to mixer apparatus **40** is not limited to three but may be a different number. Specifically, if a Bluetooth module is to be adopted as wireless communication means as in the above-described embodiment, seven music apparatus can be connected by wireless as slaves to mixer apparatus **40**, since the current piconet of Bluetooth Ver. 1.0 can have seven slaves at the maximum. However, if the number of slaves increases, the data transfer rate between mixer apparatus **40** and each slave decreases, whereby the tone quality decreases. Therefore, it is preferable that about three or four music apparatus are connected to mixer apparatus **40**. However, if the data transfer rate increases owing to a future advancement of Bluetooth technology, mixing at a high tone quality can be achieved even if the number of music apparatus connected to mixer apparatus **40** increases.

[0081] Further, an electronic musical instrument and a microphone apparatus are adopted as music apparatus **10** to **30**; however, any apparatus may be adopted as a music apparatus as long as the music apparatus can transmit audio signals or audio signal producing signals, and the combination thereof can be freely made.

[0082] Further, in the above-described embodiment, description has been made only for the case in which two tone generator circuits **42***a*, **42***b* and two decoders **43***a*, **43***b* are used in mixer apparatus **40**; however, the number of tone generator circuits and the number of decoders can be freely set. In addition, the number of MIDI data generators **47** for generating MIDI data independently from music apparatus **10** to **30** may be increased.

[0083] Further, in the above-described embodiment, mixer apparatus **40** having an electronic musical instrument function, namely mixer apparatus **40** incorporating tone generator circuits **42***a*, **42***b* that generate music tone signals, is adopted; however, a mixer apparatus that does not include an electronic musical instrument function and receives only the audio signals for mixing can be adopted as mixer apparatus **40**.

[0084] Further, when a music apparatus functioning as a new slave enters the communication range of the piconet while mixer apparatus **40** is receiving MIDI data and audio signals from music apparatus **10** to **30** such as an electronic musical instrument and a microphone apparatus and mixing the audio signals, this new music apparatus may be added into the piconet so that the new music apparatus may participate in the aforesaid mixing of audio signals. At this moment, if the new apparatus is an apparatus functioning as one of the slaves previously set in mixer apparatus **40**, the new apparatus may be added into the piconet, while in the other cases, the new music apparatus may not be added into the piconet. Further, when one or more music apparatus (slaves) have gone out of the communication range of the piconet while the audio signals are being mixed, or when the power switch of the music apparatus is turned off, the music apparatus may be excluded from the piconet.

[0085] Further, a buffer for accumulating audio data corresponding to a predetermined period of time may be provided (for example, the buffer may be disposed at the stage previous to each characteristics control circuit **44**) in order to absorb the data transmittance/reception time delays of each channel so that the data of each channel may be output in synchronization. This allows that, even if data transmittance time delays are present, sounds are not interrupted, although time delays may occur to some extent.

[0086] Further, in the above-described embodiment, electronic musical instruments having a keyboard are adopted as music apparatus **10**, **20**; however, electronic musical instruments having performance operators other than a keyboard, for example, electronic musical instruments of string instrument type, wind instrument type, percussion instrument type, and the like can be adopted as well.

[0087] Furthermore, in carrying out the present invention, it is not limited to the above-described embodiments or modifications thereof, so that various modifications can be made as long as they do not depart from the object of the present invention.

What is claimed is:

1. A mixer apparatus for inputting audio signals or audio signal producing signals respectively produced in a plurality of music apparatus and for mixing the input audio signals or audio signals produced on the basis of the input audio signal producing signals, said mixer apparatus comprising:

a wireless communication section capable of wireless communication with said plurality of music apparatus by allowing said plurality of music apparatus to function as slaves and allowing said mixer apparatus itself to function as a master, said wireless communication section respectively receiving said audio signals or audio signal producing signals that are transmitted from said plurality of music apparatus; and

a mixing section for mixing the audio signals received by said wireless communication section or the audio signals produced on the basis of the audio signal producing signals received by said wireless communication section.

2. The mixer apparatus according to claim 1, wherein said wireless communication section respectively issues requests to said plurality of music apparatus for transmittance of said audio signals or audio signal producing signals, and respectively receives said audio signals or audio signal producing signals that are transmitted from said plurality of music apparatus in response to said requests for transmittance.

3. The mixer apparatus according to claim 1, wherein said wireless communication section receives said audio signals or audio signal producing signals from said plurality of music apparatus by isochronous communication procedure.

4. The mixer apparatus according to claim 1, further comprising mixed signal transmitting section for transmitting the audio signals mixed in said mixing section to said plurality of music apparatus via said wireless communication section.

5. The mixer apparatus according to claim 4, wherein said wireless communication section transmits the audio signals mixed in said mixing section to said plurality of music apparatus by broadcast communication procedure.

6. The mixer apparatus according to claim 1, further comprising communication condition setting section for setting conditions of communication with said plurality of music apparatus in a state in which a wireless connection is established between said mixer apparatus and said plurality of music apparatus.

7. The mixer apparatus according to claim 1, further comprising wired input section connected by wire to a different music apparatus other than said plurality of music apparatus, for wired input of audio signals or audio signal producing signals for producing audio signals that are output from the different music apparatus, wherein

said mixing section also mixes the audio signals input by said wired input section or the audio signals produced on the basis of the audio signal producing signals input by said wired input section, in addition to the audio signals received by said wireless communication section or the audio signals produced on the basis of the audio signal producing signals received by said wireless communication section.

8. The mixer apparatus according to claim 1, further comprising audio signal generating section for generating audio signals independently from said plurality of music apparatus, wherein said mixing sectional so mixes the audio signals generated by said audio signal generating section, in addition to the audio signals received by said wireless communication section or the audio signals produced on the basis of the audio signal producing signals received by said wireless communication section.

9. A mixer apparatus comprising:

a wireless communication section for receiving by wireless first audio signals or first audio signal producing signals from a plurality of first music apparatus; and

a mixing section for mixing the received first audio signals or second audio signals produced on the basis of the received first audio signal producing signals, wherein

said mixing section mixes third audio signals or forth audio signals produced on the basis of second audio signal producing signals in addition to the received first audio signals and the produced second audio signals, when said wireless communication section receives by wireless the third audio signals or the second audio signal producing signals from a second music apparatus while said mixing section is mixing the received first audio signals or the produced second audio signals.

10. A music apparatus capable of wireless communication with a mixer apparatus that mixes a plurality of audio signals, wherein the music apparatus comprises:

mixing signal generating section for generating said audio signals that will be subjected to mixing or audio signal producing signals for producing said audio signals that will be subjected to mixing;

a wireless communication section for transmitting by wireless to said mixer apparatus the audio signals or the audio signal producing signals generated by said mixing signal generating section and for receiving mixed signals mixed by said mixer apparatus and transmitted by wireless from said mixer apparatus, said mixed signals including said audio signals transmitted by wireless from said music apparatus or the audio signals

produced on the basis of said audio signal producing signals transmitted by wireless from said music apparatus; and

reproduction section for reproducing the mixed signals received by said wireless communication section.

11. A computer readable program applied to a mixer apparatus:

said mixer apparatus comprising a wireless communication section for receiving audio signals or audio signal producing signals for producing audio signals that are transmitted by wireless from a plurality of music apparatus, and mixing the audio signals received by said wireless communication section or the audio signals produced on the basis of the audio signal producing signals received by said wireless communication section, wherein

said computer readable program allows said wireless communication section to function as a master and allows said plurality of music apparatus to function as slaves.

12. A computer readable program according to claim 11, wherein

said computer readable program allows said wireless communication section

to operate to issue requests to said plurality of music apparatus for transmittance of said audio signals or audio signal producing signals, and

to operate to receive said audio signals or audio signal producing signals that are transmitted from said plurality of music apparatus in response to said requests for transmittance.

* * * * *

US006084168A

United States Patent [19]

Sitrick

[11] **Patent Number: 6,084,168**

[45] **Date of Patent: Jul. 4, 2000**

[54] **MUSICAL COMPOSITIONS COMMUNICATION SYSTEM, ARCHITECTURE AND METHODOLOGY**

[76] Inventor: **David H. Sitrick**, 820 Burchell, Highland Park, Ill. 60035

[21] Appl. No.: **09/039,952**

[22] Filed: **Mar. 16, 1998**

Related U.S. Application Data

[63] Continuation-in-part of application No. 08/677,469, Jul. 10, 1996, Pat. No. 5,728,960.

[51] **Int. Cl.**[7] **G09B 15/02**

[52] **U.S. Cl.** .... **84/477 R**; 84/478; 84/DIG. 6

[58] **Field of Search** .... 84/461, 462, 464 A, 84/464 R, 477 R, 478, 601–602, DIG. 6

[56] **References Cited**

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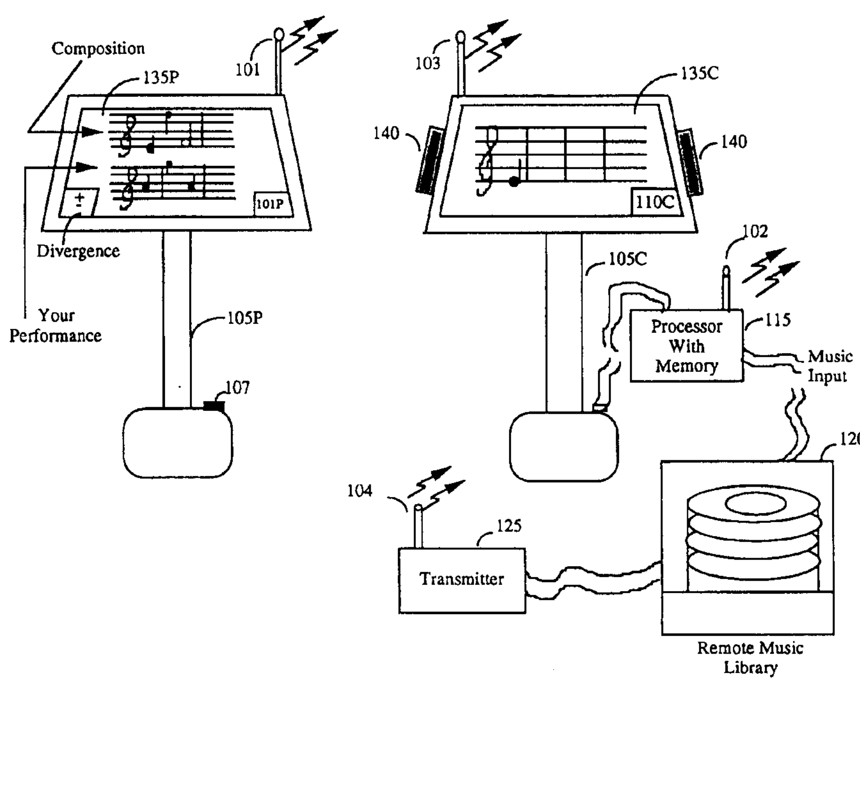
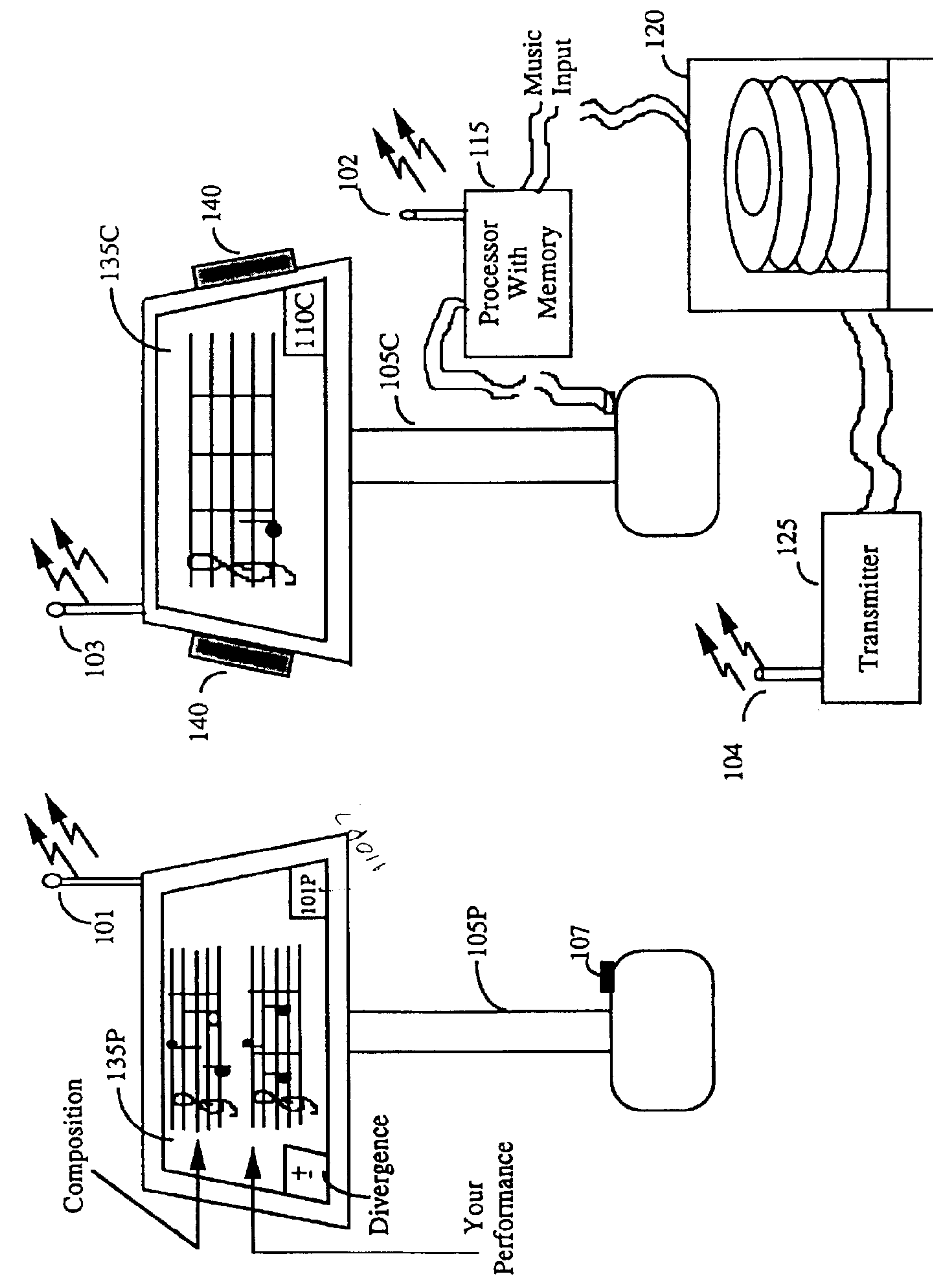
Primary Examiner—Robert E. Nappi
Assistant Examiner—Marlon T. Fletcher
Attorney, Agent, or Firm—Sitrick & Sitrick

[57] **ABSTRACT**

A musical workstation system produces a display presentation in one of a musical composition responsive to musical composition data and responsive to one or both of input variables and a selected operating mode. The system is comprised of (1) means to provide the musical composition data (such as local storage (ROM, RAM, CD-ROM, hard disk etc.), or via a communications interface to an external device (such as another music workstation, a master controller, a computer), a memory, a selection subsystem, a controller, and a display subsystem. The memory selectively stores the received original musical compositions. The selection subsystem determines a selected operating mode and display format. The controller, responsive to the selection subsystem, provides means for selectively controlling the storing of the musical composition data in memory and selectively processing (e.g. altering) the stored musical composition data responsive to the selected operating mode and the input variables to produce a particular one of a plurality of processed results, such as external communications, operating, mode, transformation to derivative musical compositions, etc. The music workstation can communicate with one or more external devices, such as other music workstations, a master workstation, a controller, etc. The display system provides for selection of original compositions, creation of derivative compositions, distribution of compositions, monitoring of each performer's performance, group virtual performances, and also allows for local and distributed retrieval and editing of musical compositions, such as changing keys, pitch, tempo, and many other parameters. The music transformation can be performed locally or at the central or distributed music database, which stores the scores of musical composition. The musical composition data can be transposed via a controller, and can be transmitted to a plurality of the individual music workstations that then display the music composition, to permit playing by musical instruments or vocalists, and for location presentation.

54 Claims, 27 Drawing Sheets





101
135P
101P
105P
107
Composition
Divergence
Your Performance
103
140
135C
110C
105C
102
115
Processor With Memory
Music Input
120
Remote Music Library
125
Transmitter
104

FIG. 1A

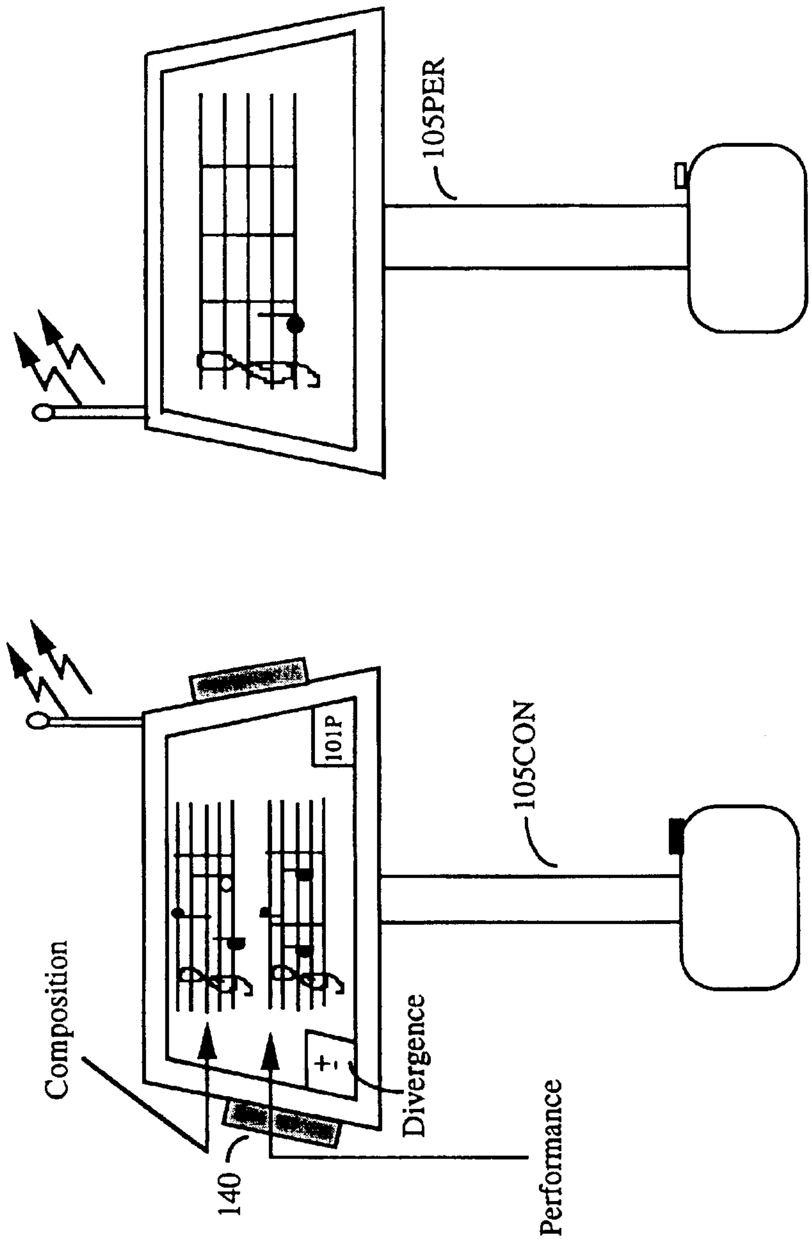
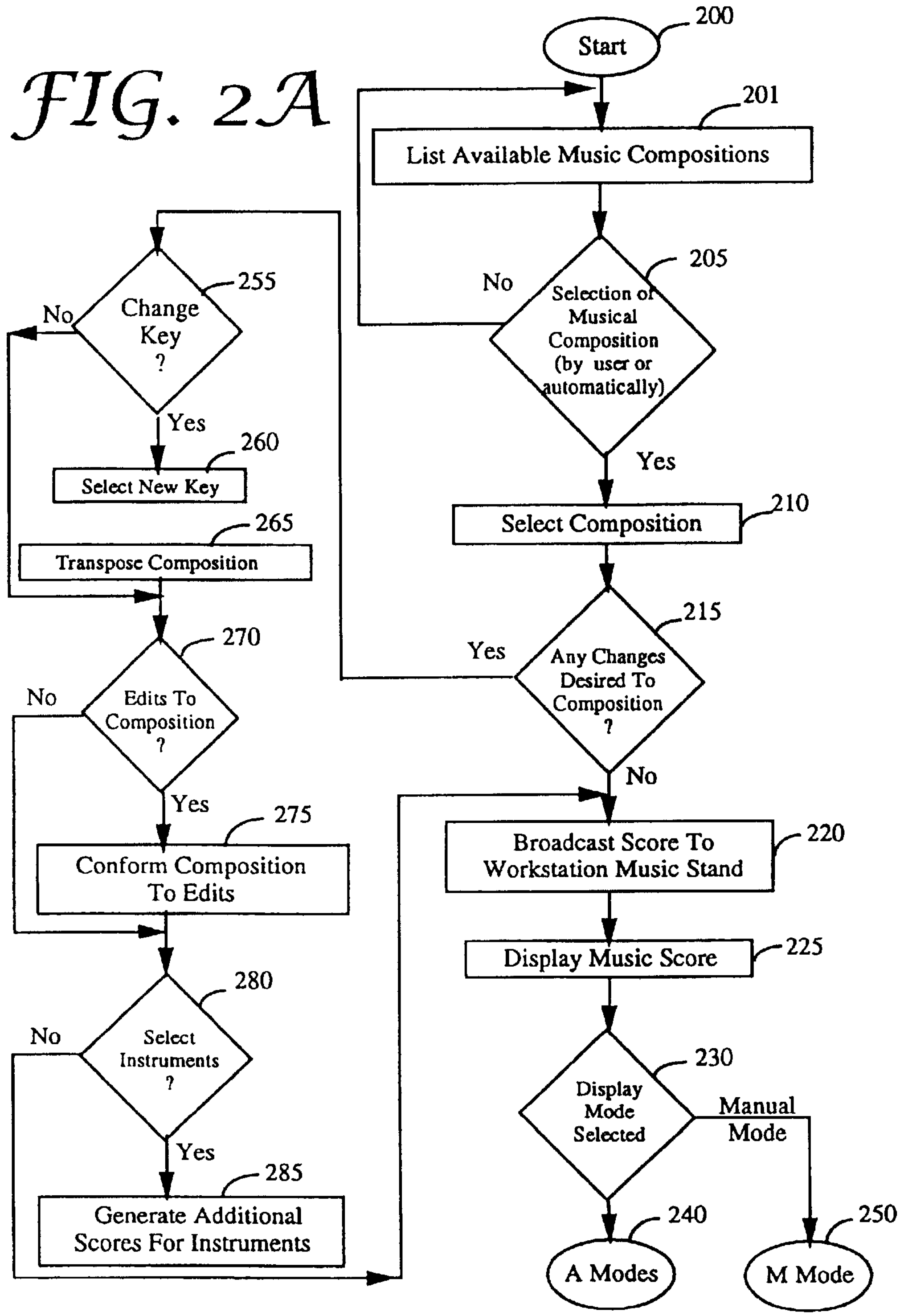

105PER
105CON
101P
Composition
Divergence
Performance
140

FIG. 1B

FIG. 2A


Start
200
201
List Available Music Compositions
205
No
Selection of Musical Composition (by user or automatically)
Yes
Select Composition
210
215
Yes
Any Changes Desired To Composition ?
No
Broadcast Score To Workstation Music Stand
220
Display Music Score
225
230
Display Mode Selected
Manual Mode
240
250
A Modes
M Mode
255
No
Change Key ?
Yes
260
Select New Key
265
Transpose Composition
270
No
Edits To Composition ?
Yes
275
Conform Composition To Edits
280
No
Select Instruments ?
Yes
285
Generate Additional Scores For Instruments

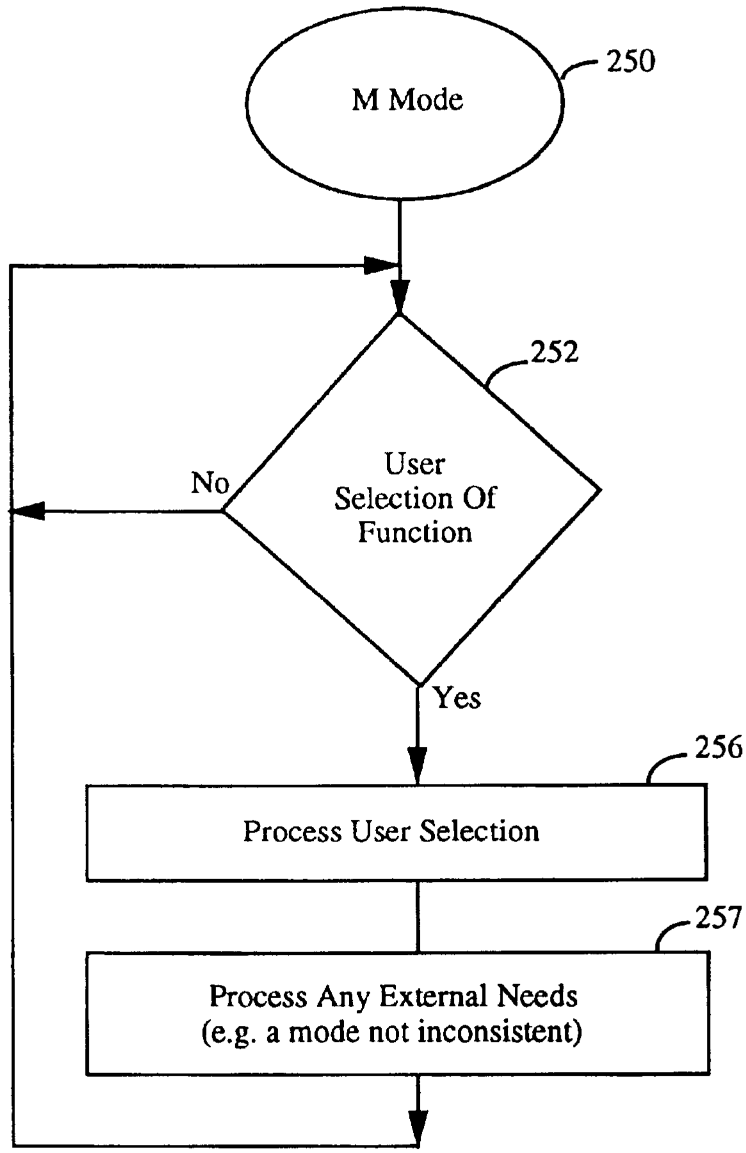

M Mode
250
252
No
User
Selection Of
Function
Yes
256
Process User Selection
257
Process Any External Needs
(e.g. a mode not inconsistent)

FIG. 2B

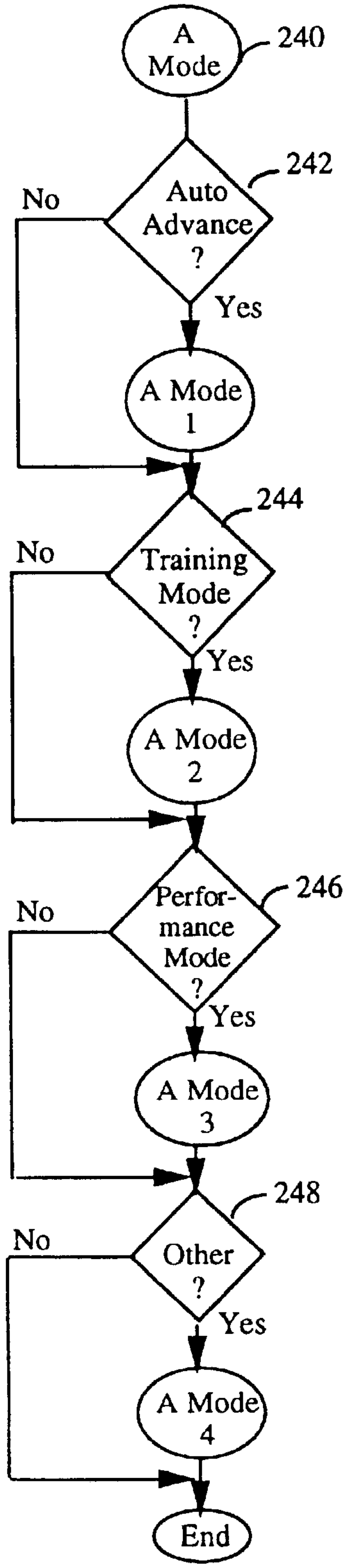
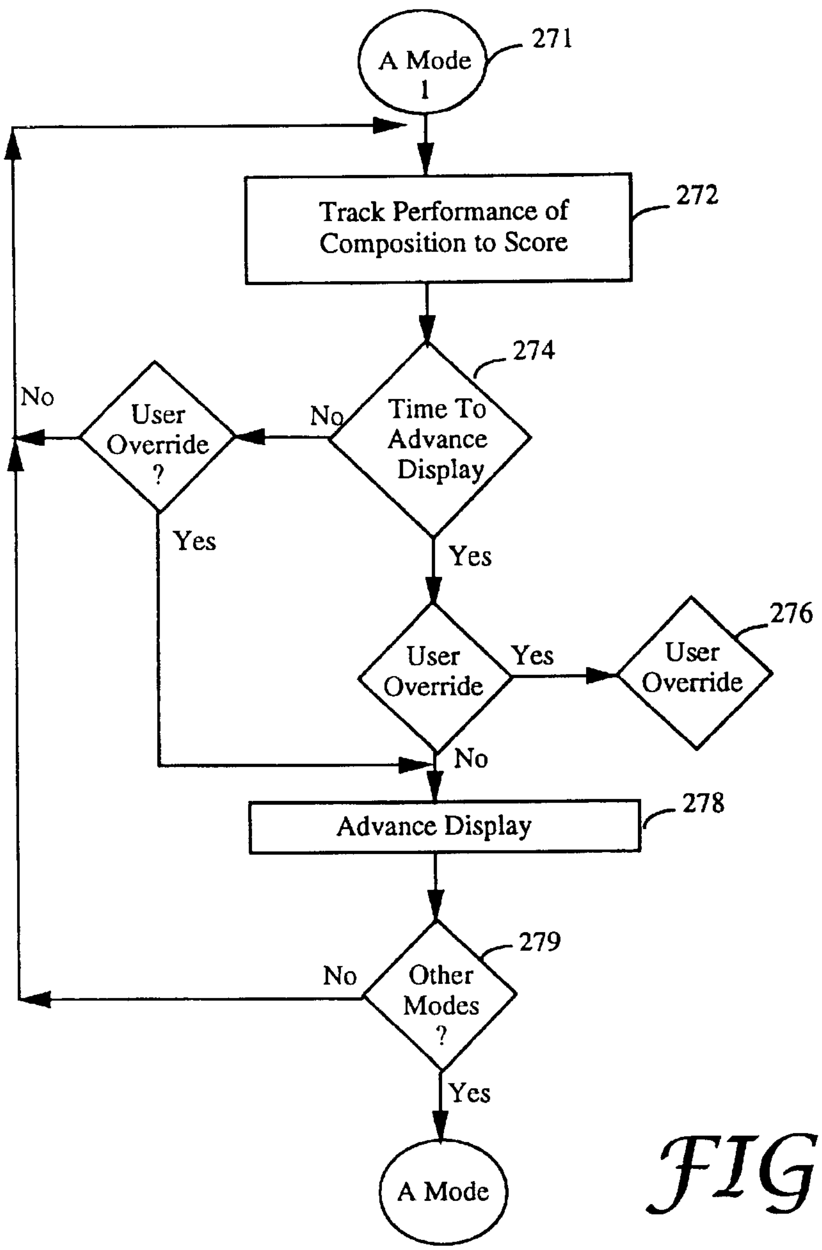

A Mode
240
Auto Advance ?
242
No
Yes
A Mode 1
Training Mode ?
244
No
Yes
A Mode 2
Perfor-mance Mode ?
246
No
Yes
A Mode 3
Other ?
248
No
Yes
A Mode 4
End

FIG. 2C



A Mode
1
271
Track Performance of
Composition to Score
272
274
Time To
Advance
Display
No
User
Override
?
No
Yes
Yes
User
Override
Yes
User
Override
276
No
Advance Display
278
Other
Modes
?
279
No
Yes
A Mode

FIG. 2D

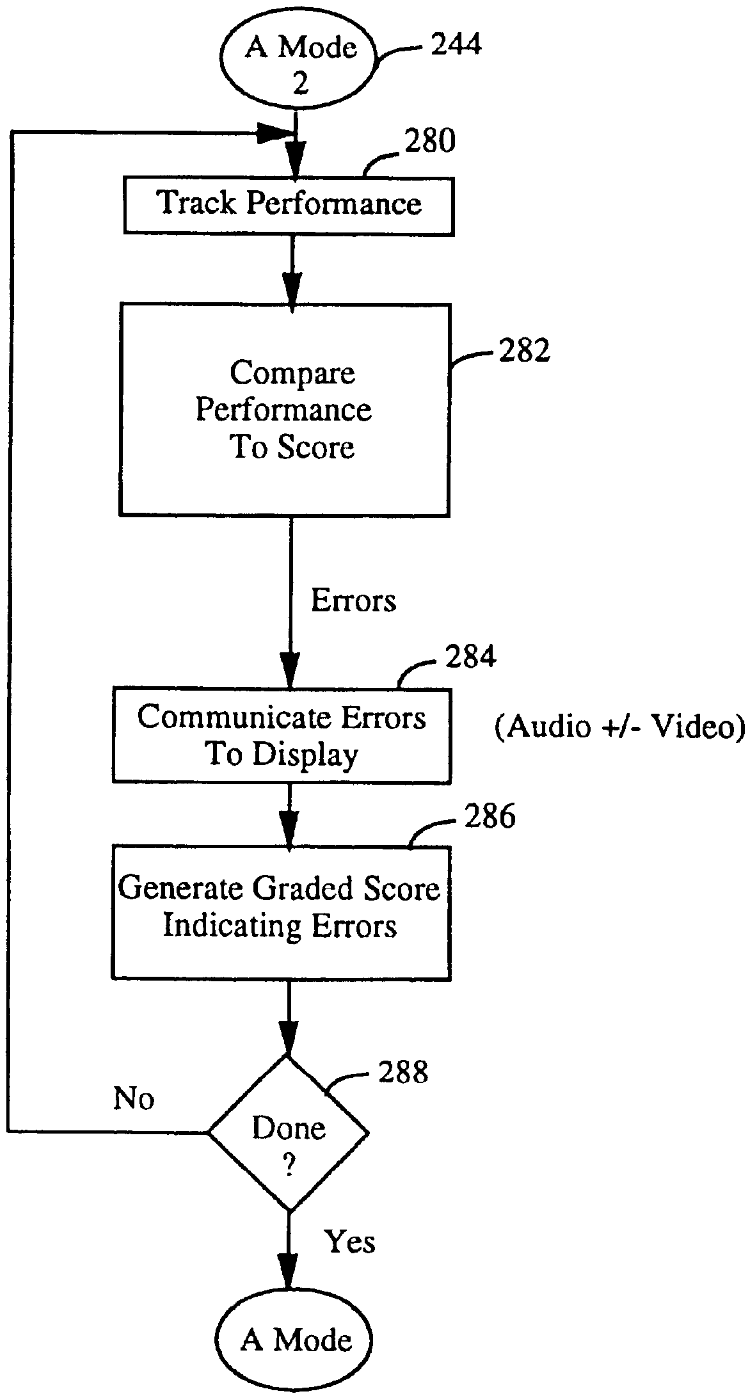
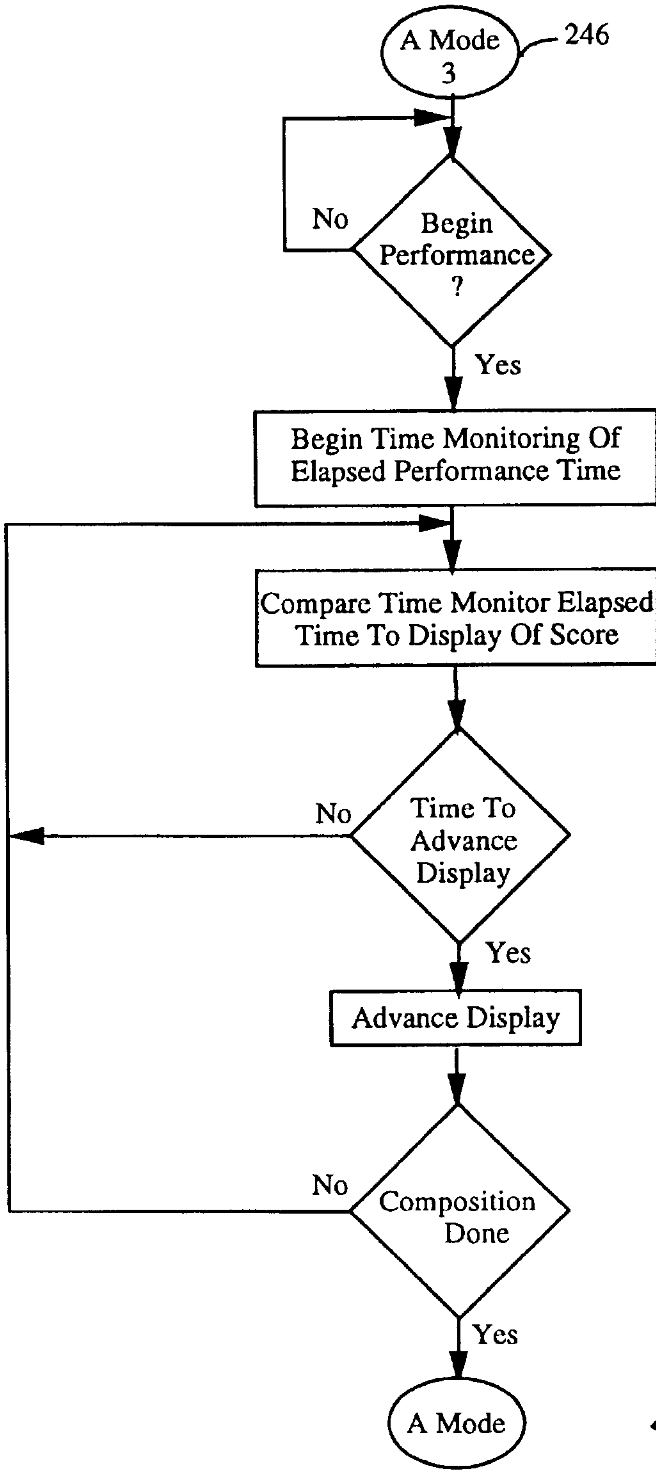

A Mode 2
244
280
Track Performance
282
Compare Performance To Score
Errors
284
Communicate Errors To Display
(Audio +/- Video)
286
Generate Graded Score Indicating Errors
288
No
Done ?
Yes
A Mode

FIG. 2E

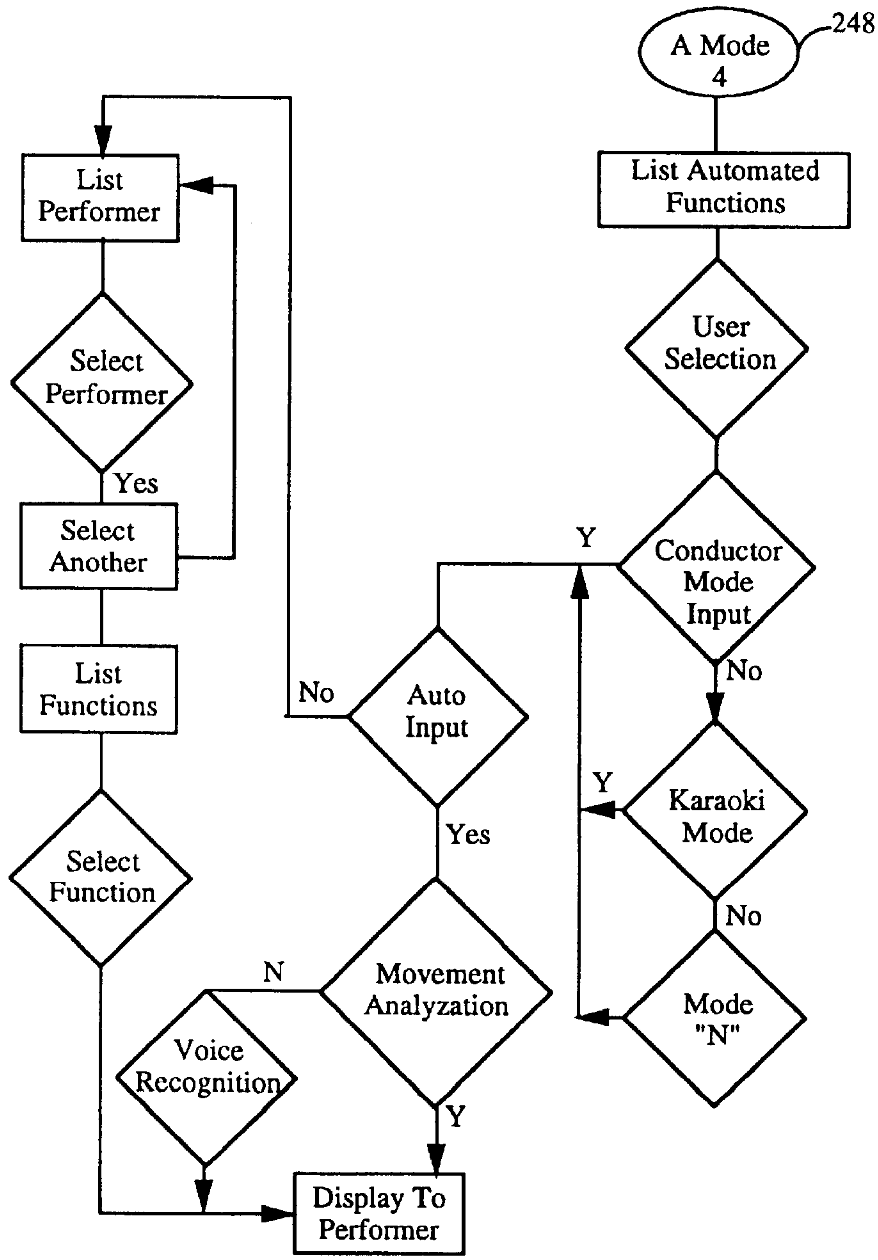


A Mode 3
246
Begin Performance ?
No
Yes
Begin Time Monitoring Of Elapsed Performance Time
Compare Time Monitor Elapsed Time To Display Of Score
Time To Advance Display
No
Yes
Advance Display
Composition Done
No
Yes
A Mode

FIG. 2F

FIG. 2G

CONDUCTOR MODE



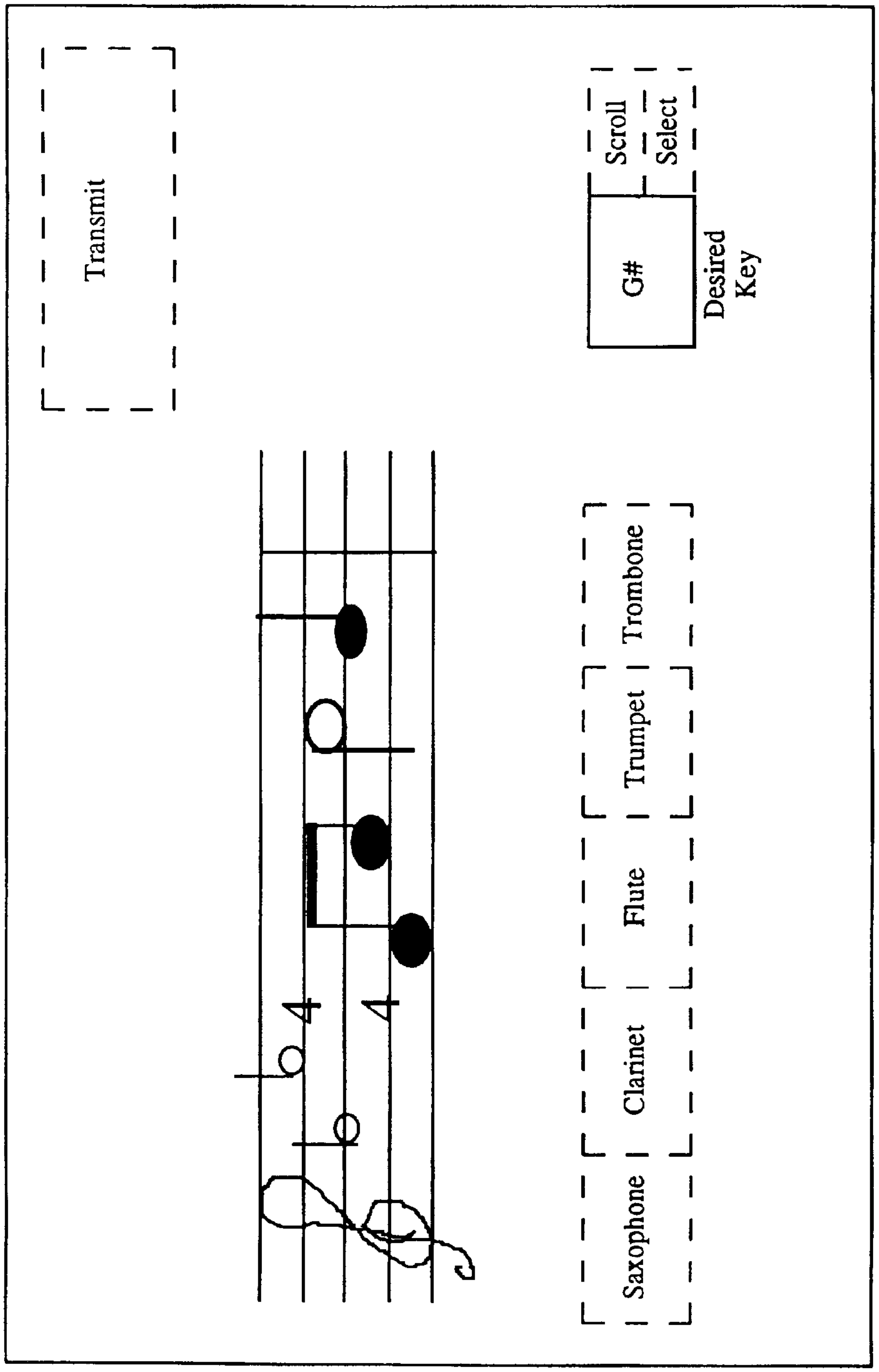
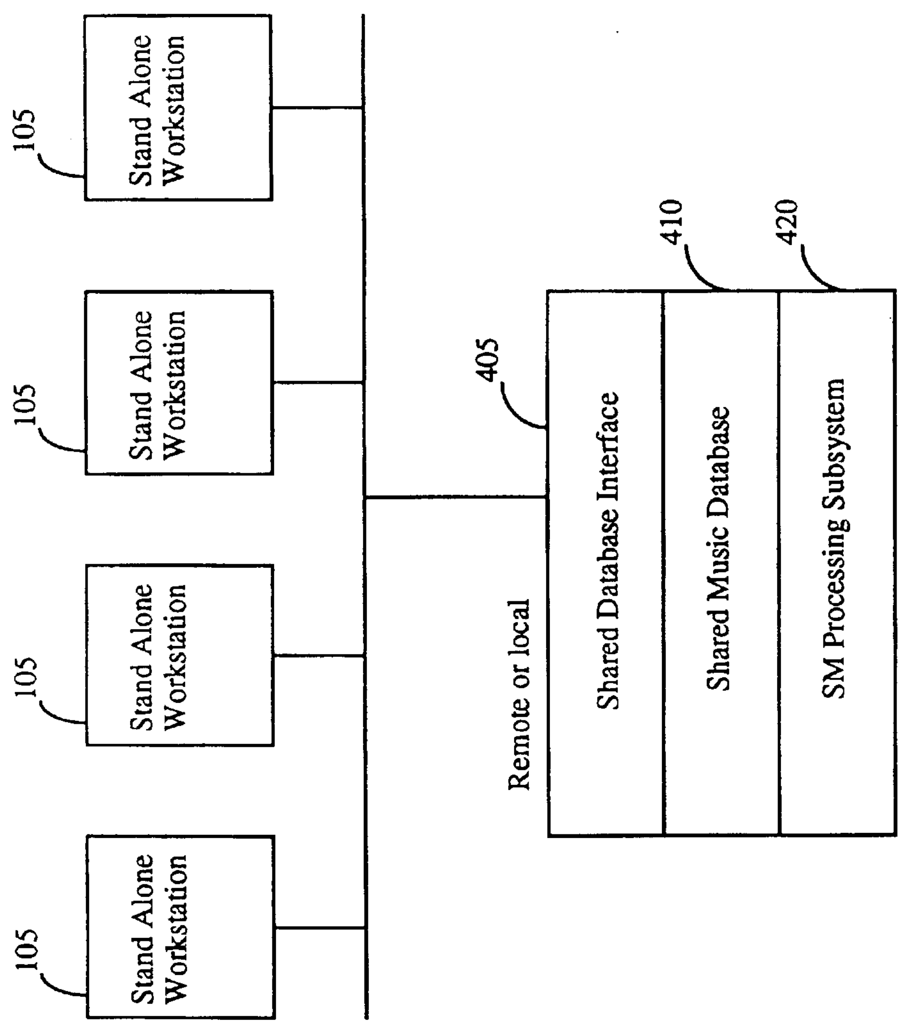

Transmit
Scroll
Select
G#
Desired Key
Saxophone
Clarinet
Flute
Trumpet
Trombone

FIG. 3

FIG. 4


105
Stand Alone Workstation
105
Stand Alone Workstation
105
Stand Alone Workstation
105
Stand Alone Workstation
Remote or local
405
Shared Database Interface
410
Shared Music Database
420
SM Processing Subsystem

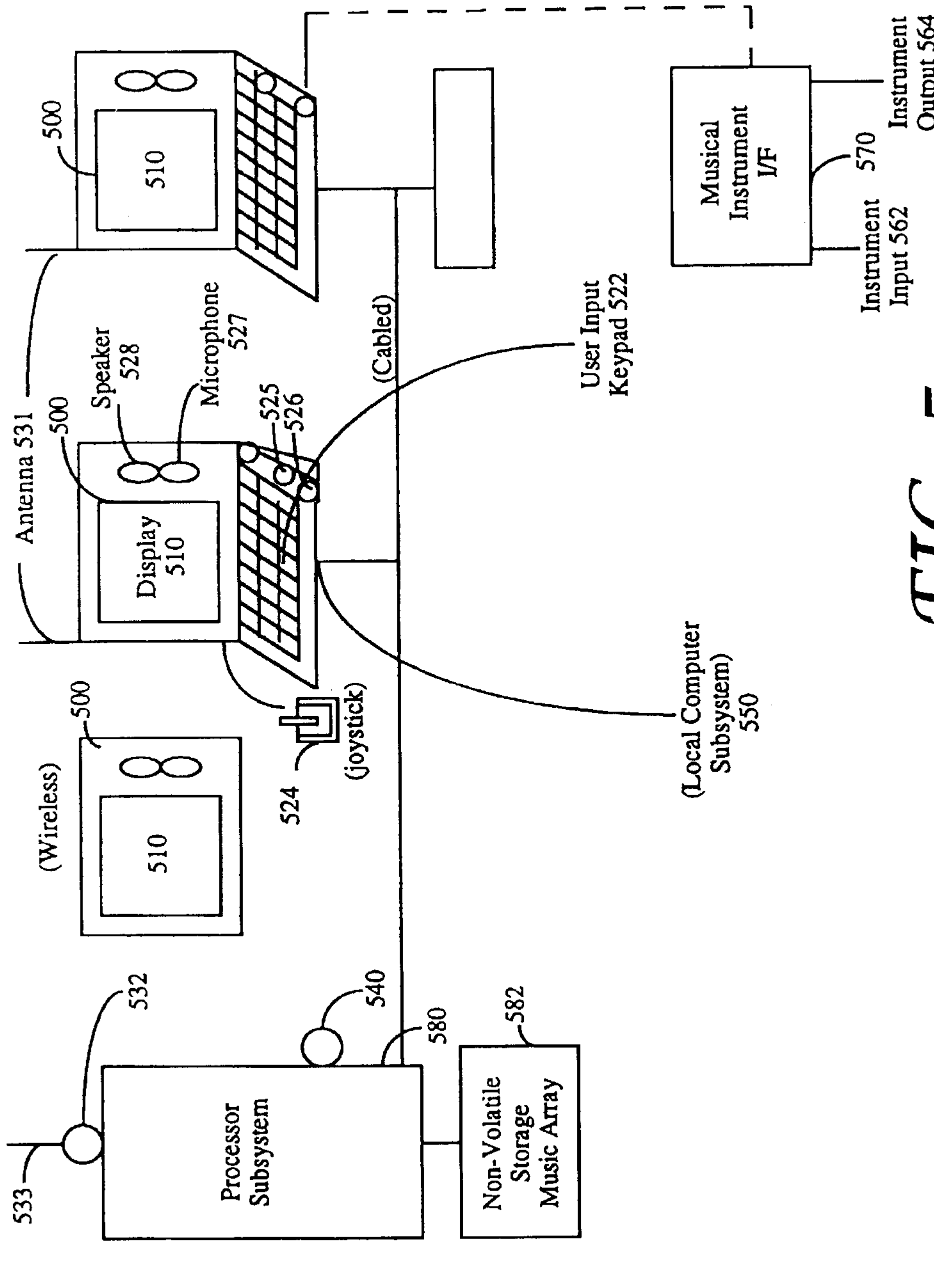

500
510
Antenna 531
Speaker 528
Microphone 527
500
525
526
Display 510
(Cabled)
User Input Keypad 522
Musical Instrument I/F
570
Instrument Output 564
Instrument Input 562
(Local Computer Subsystem) 550
500
(Wireless)
510
524
(joystick)
532
540
580
582
533
Processor Subsystem
Non-Volatile Storage Music Array

FIG. 5

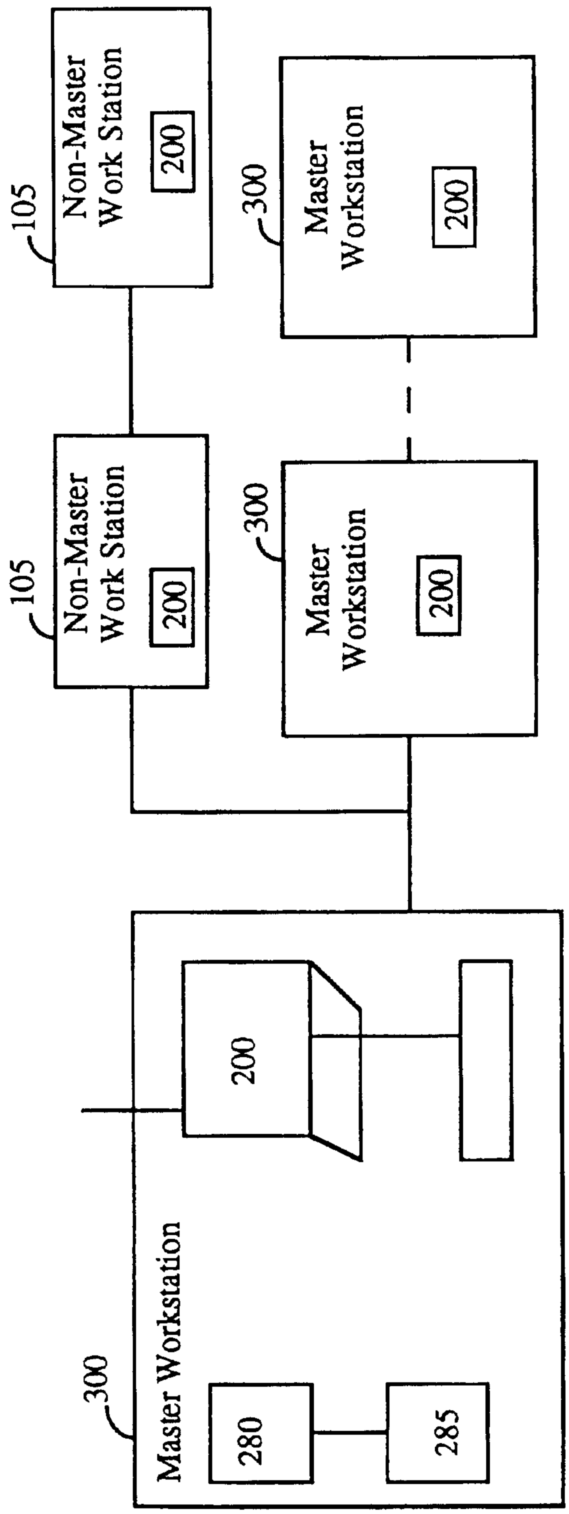

105
Non-Master
Work Station
200
105
Non-Master
Work Station
200
300
Master
Workstation
200
300
Master
Workstation
200
300
Master Workstation
200
280
285

FIG. 6

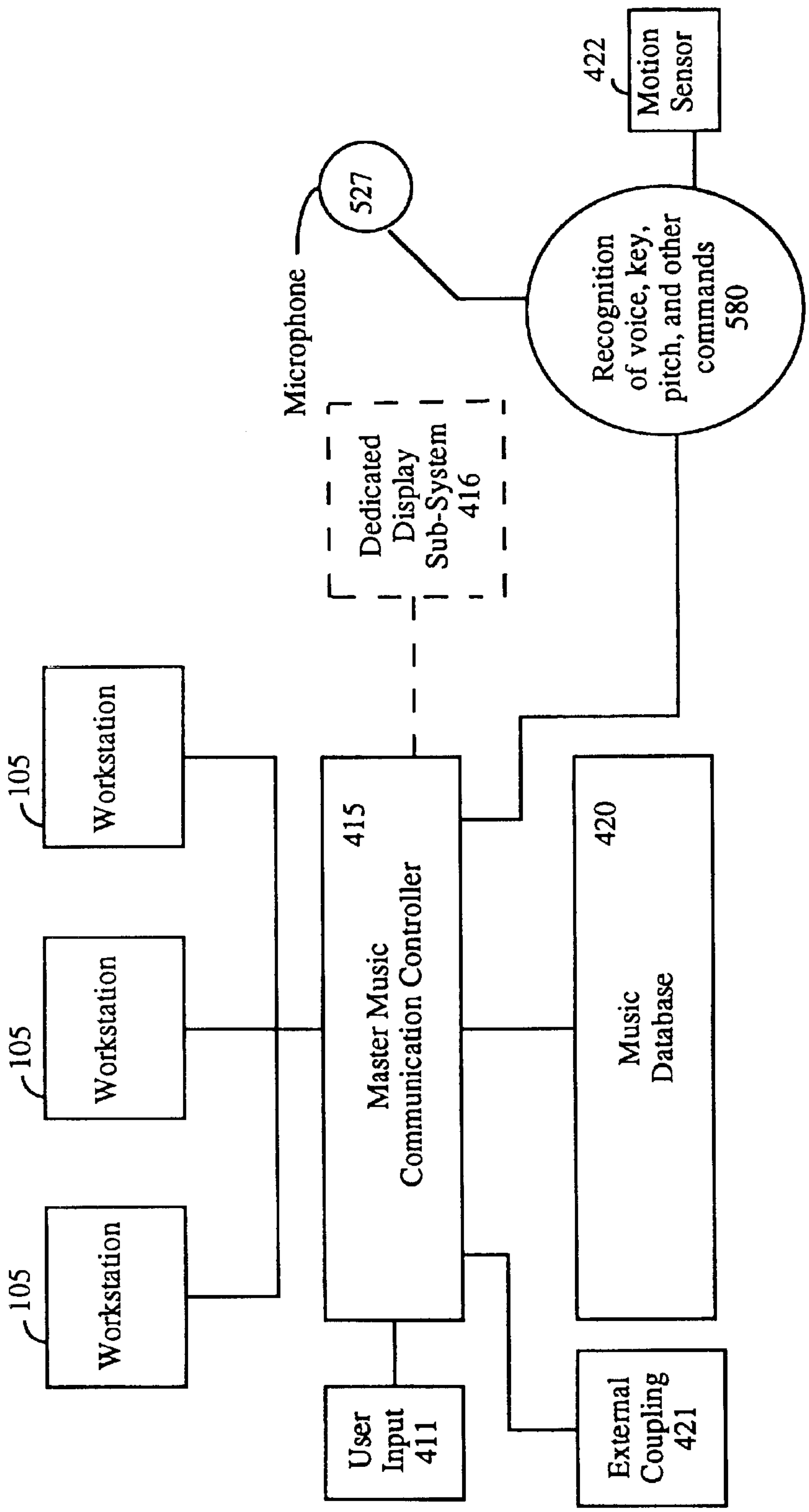

Motion Sensor
422
527
Microphone
Recognition of voice, key, pitch, and other commands 580
Dedicated Display Sub-System 416
105
Workstation
105
Workstation
105
Workstation
415
Master Music Communication Controller
420
Music Database
User Input 411
External Coupling 421

FIG. 7

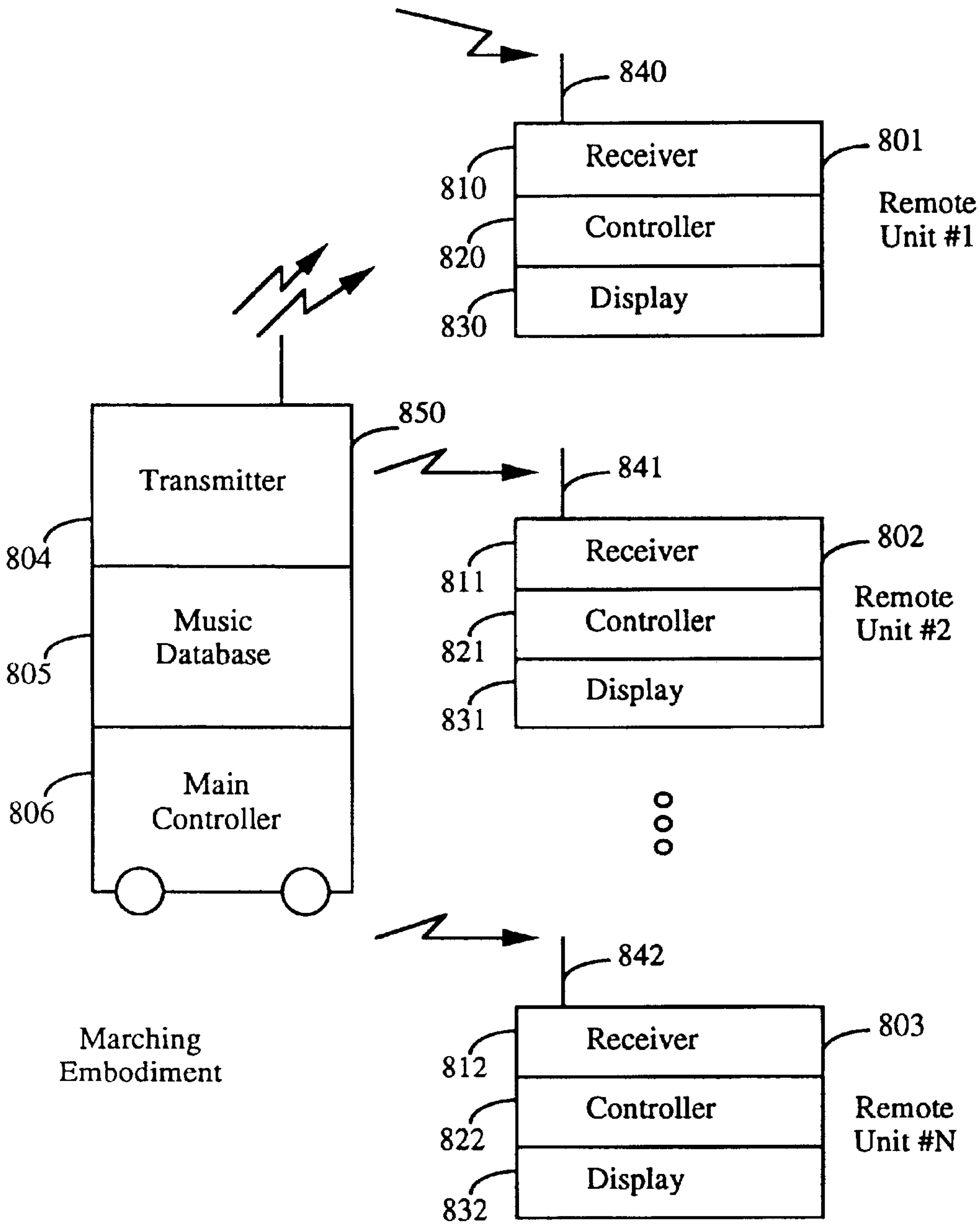

840
Receiver
801
810
Remote
Unit #1
Controller
820
Display
830
850
Transmitter
841
804
Receiver
802
811
Remote
Unit #2
Music
Database
Controller
821
805
Display
831
Main
Controller
806
842
Marching
Embodiment
Receiver
803
812
Controller
Remote
Unit #N
822
Display
832

FIG. 8

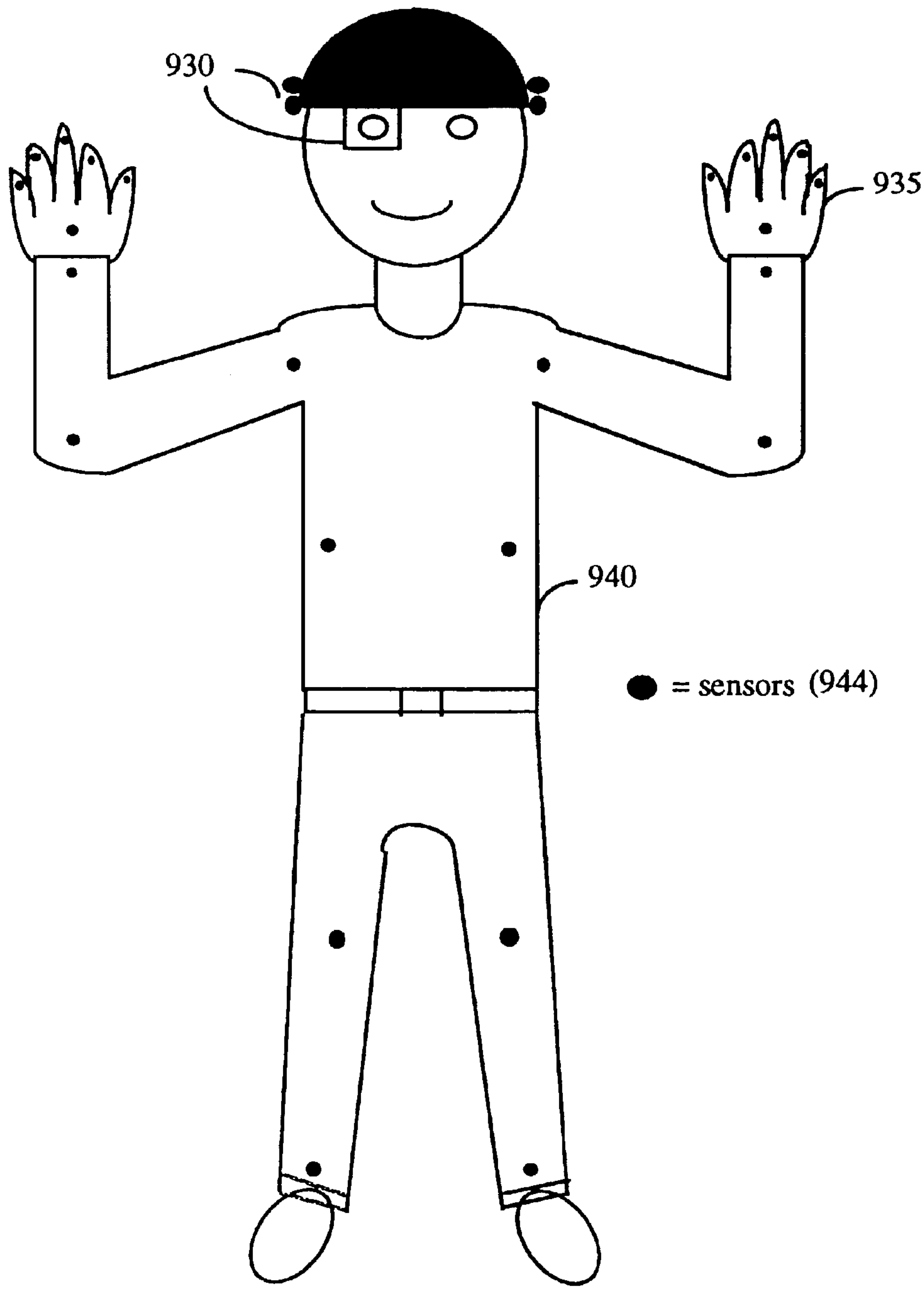


FIG. 9

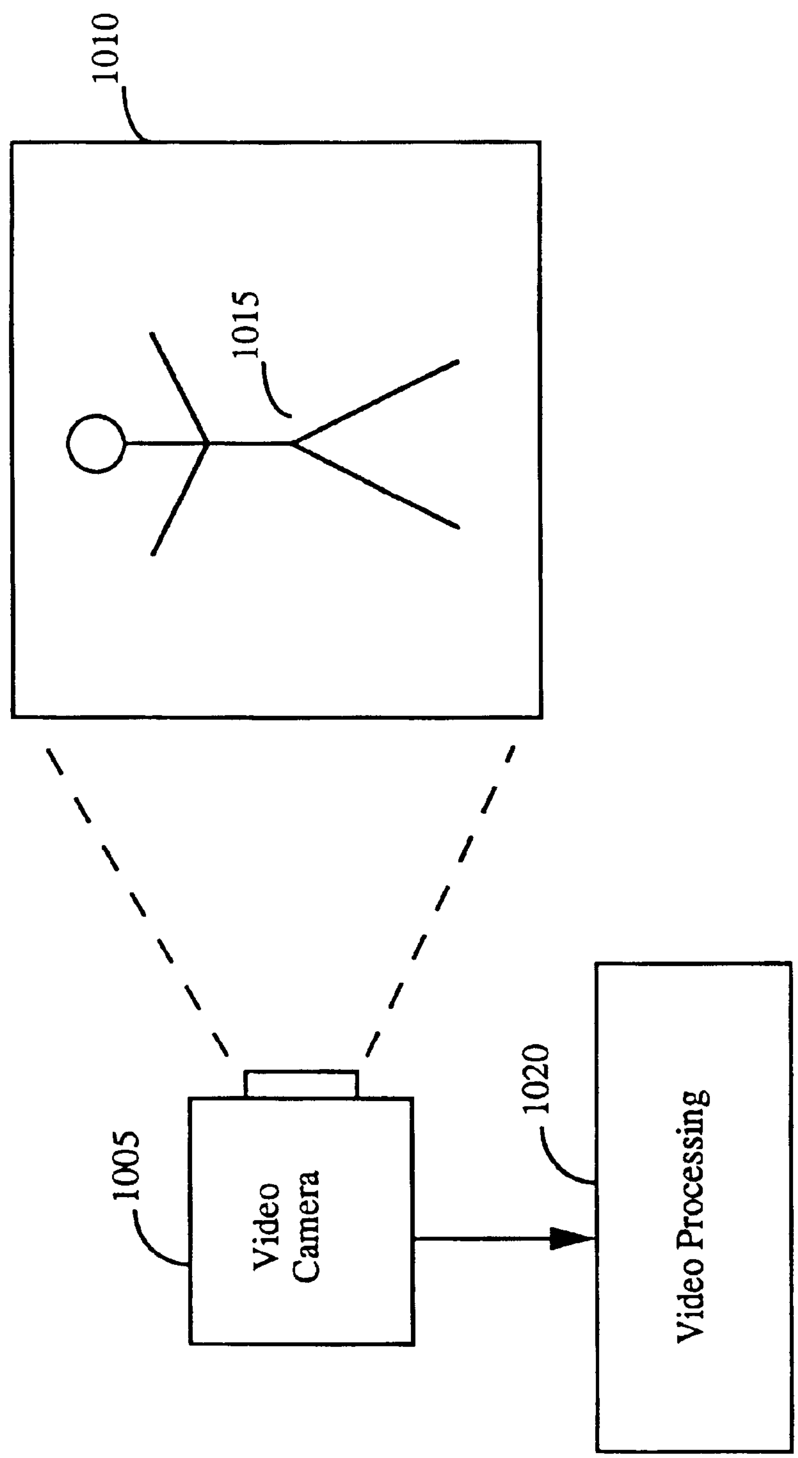


FIG. 10

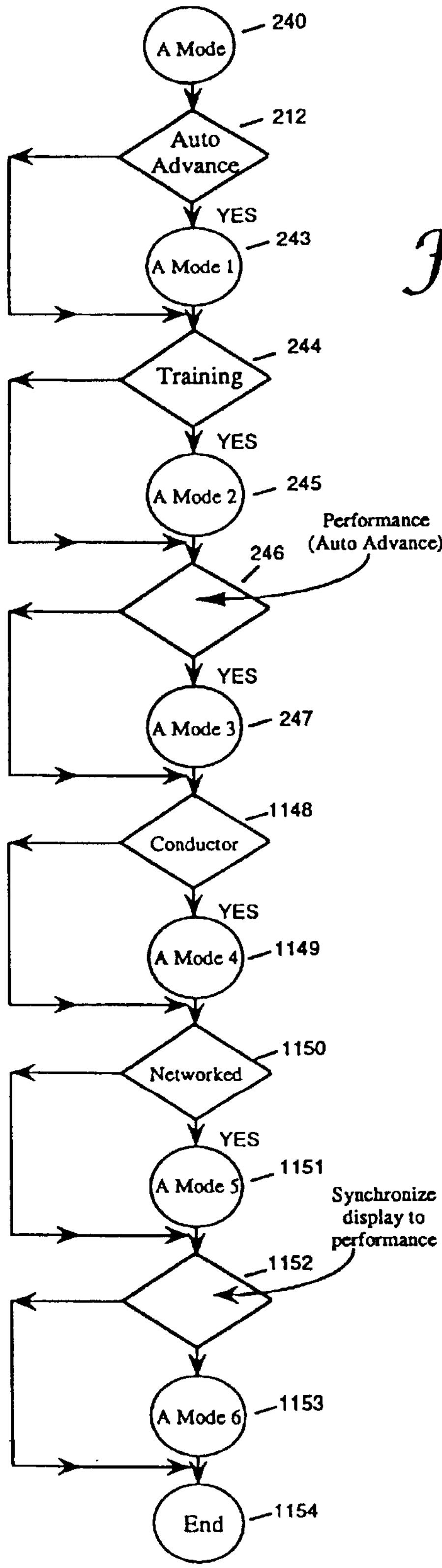

A Mode
240
Auto Advance
212
YES
A Mode 1
243
Training
244
YES
A Mode 2
245
Performance (Auto Advance)
246
YES
A Mode 3
247
Conductor
1148
YES
A Mode 4
1149
Networked
1150
YES
A Mode 5
1151
Synchronize display to performance
1152
A Mode 6
1153
End
1154

FIG. 11A

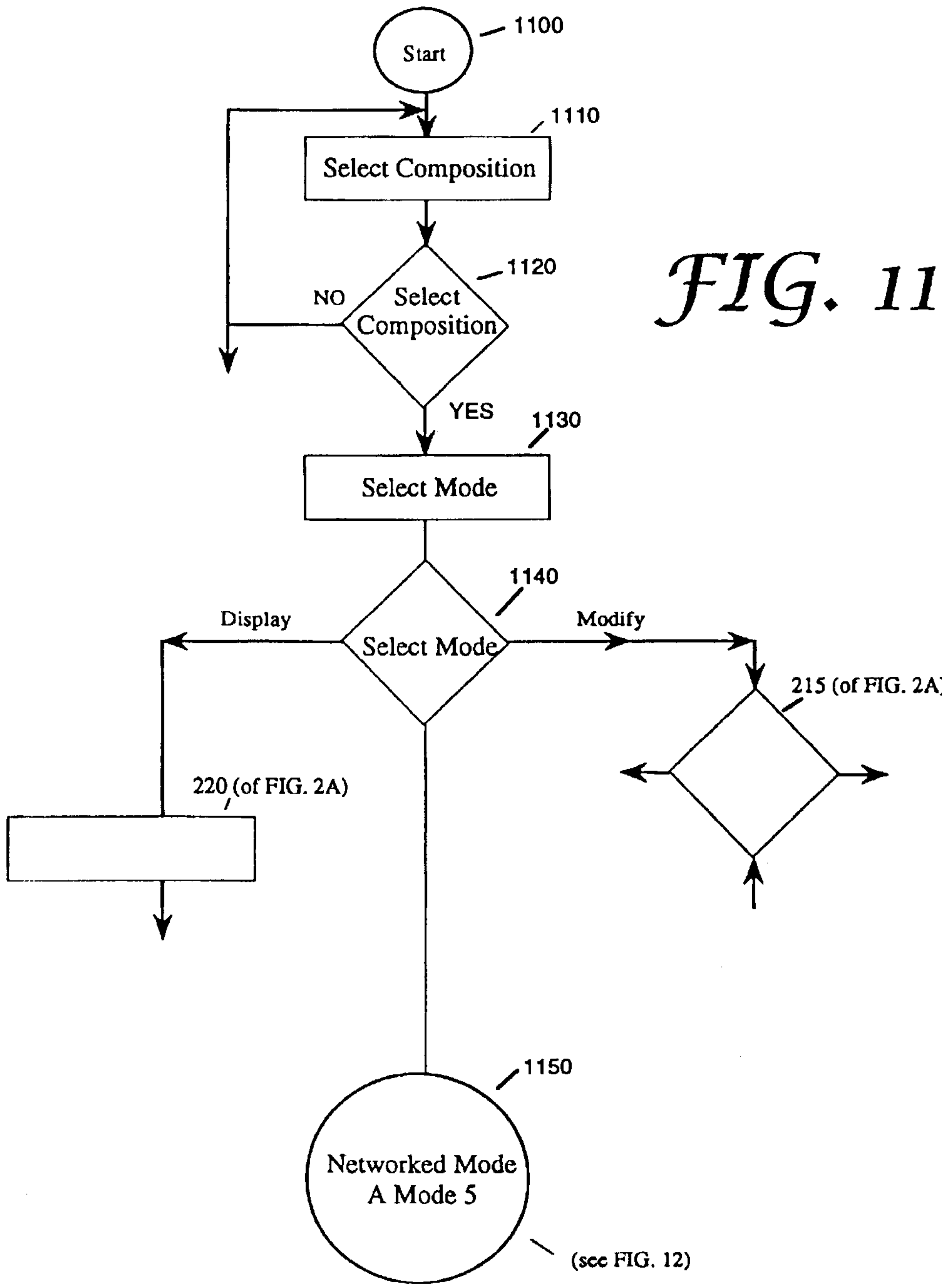

Start
1100
1110
Select Composition
1120
NO
Select Composition
YES
1130
Select Mode
1140
Display
Modify
Select Mode
215 (of FIG. 2A)
220 (of FIG. 2A)
1150
Networked Mode
A Mode 5
(see FIG. 12)

FIG. 11B

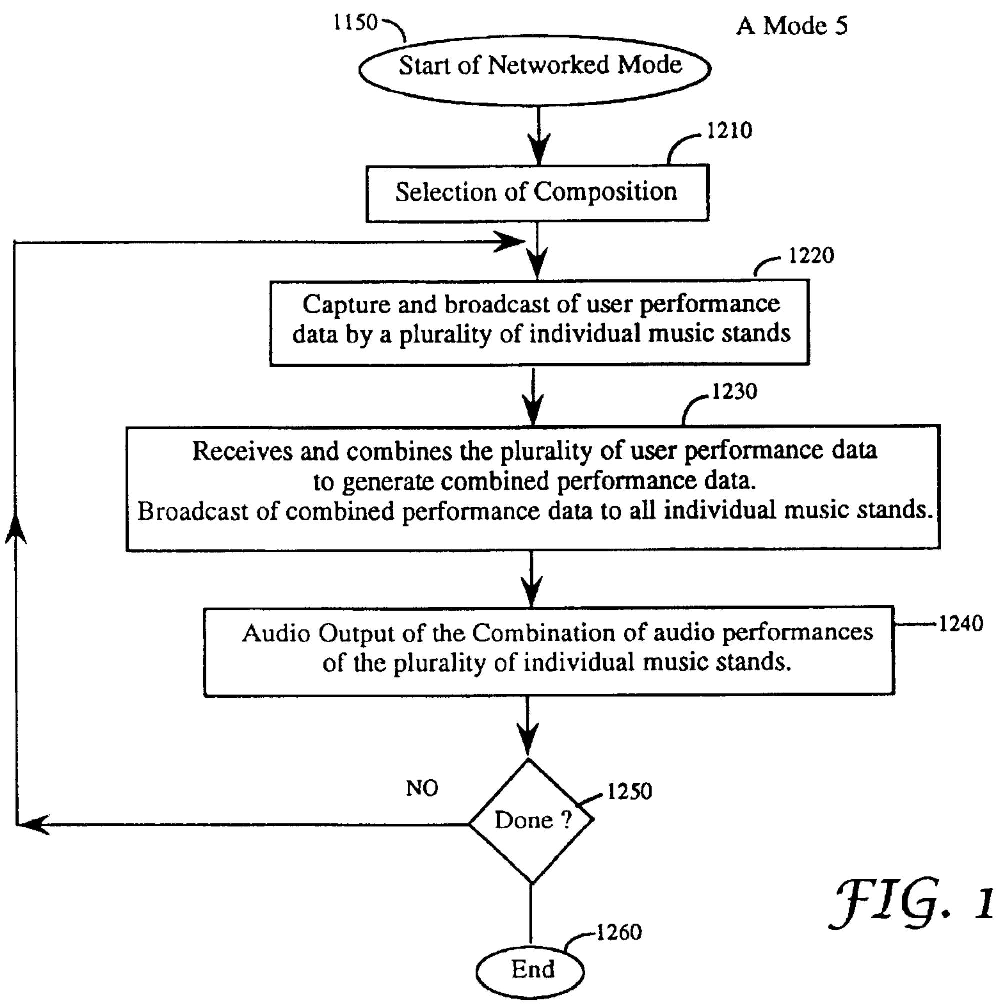
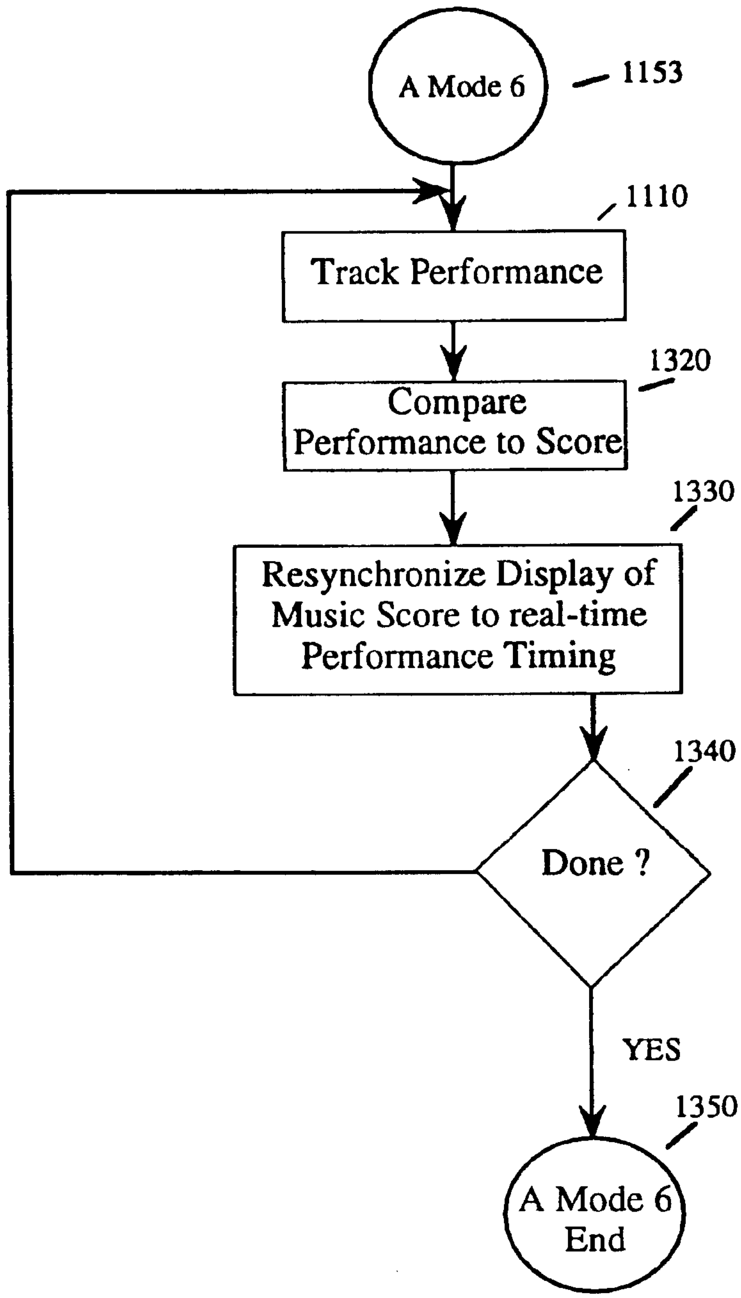

1150
A Mode 5
Start of Networked Mode
1210
Selection of Composition
1220
Capture and broadcast of user performance data by a plurality of individual music stands
1230
Receives and combines the plurality of user performance data to generate combined performance data.
Broadcast of combined performance data to all individual music stands.
1240
Audio Output of the Combination of audio performances of the plurality of individual music stands.
NO
1250
Done ?
1260
End

FIG. 12

FIG. 13


A Mode 6
1153
1110
Track Performance
1320
Compare
Performance to Score
1330
Resynchronize Display of
Music Score to real-time
Performance Timing
1340
Done ?
YES
1350
A Mode 6
End

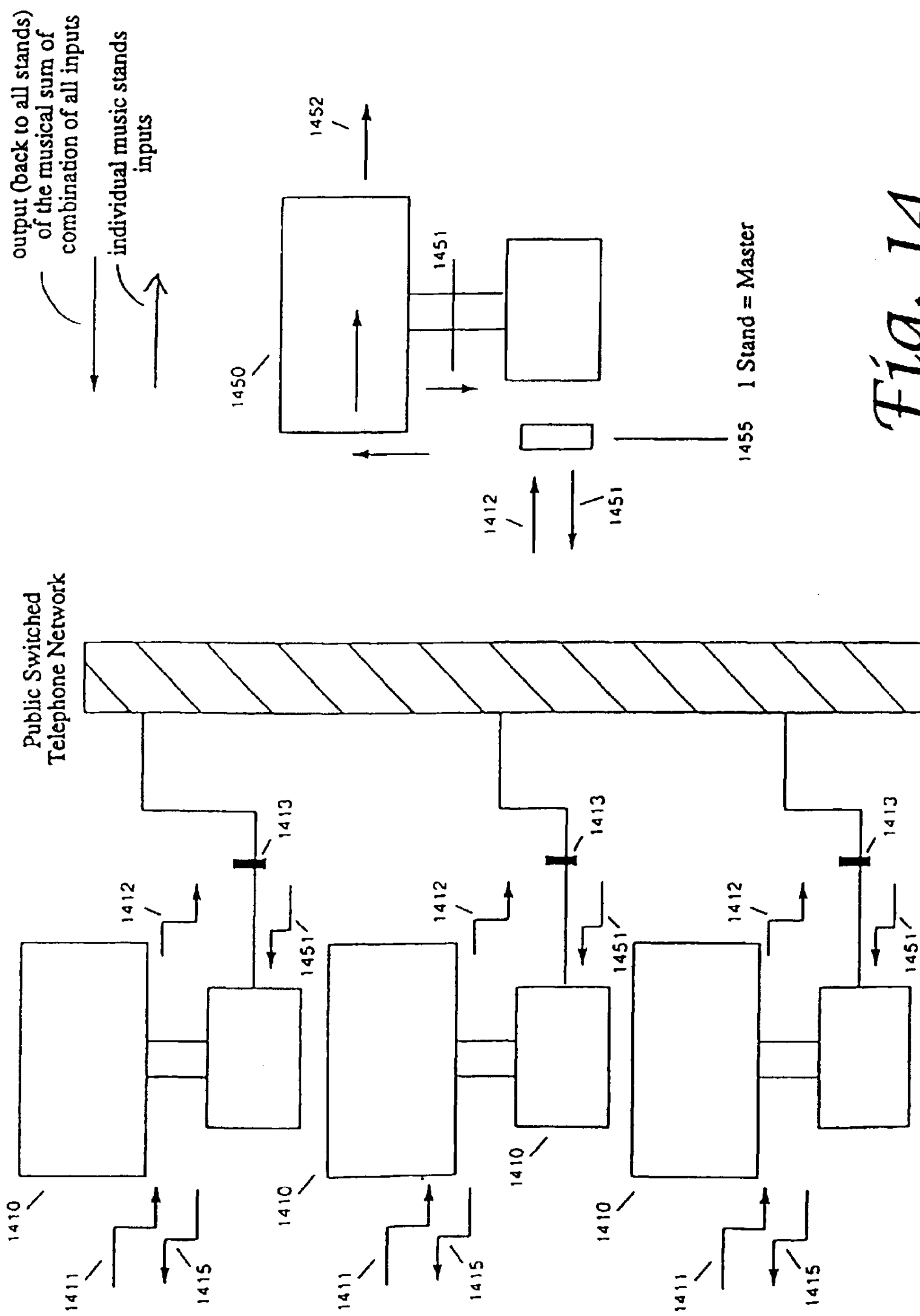

output (back to all stands) of the musical sum of combination of all inputs
individual music stands inputs
1452
1451
1450
1 Stand = Master
1455
1412
1451
Public Switched Telephone Network
1413
1412
1451
1410
1411
1415

Fig. 14

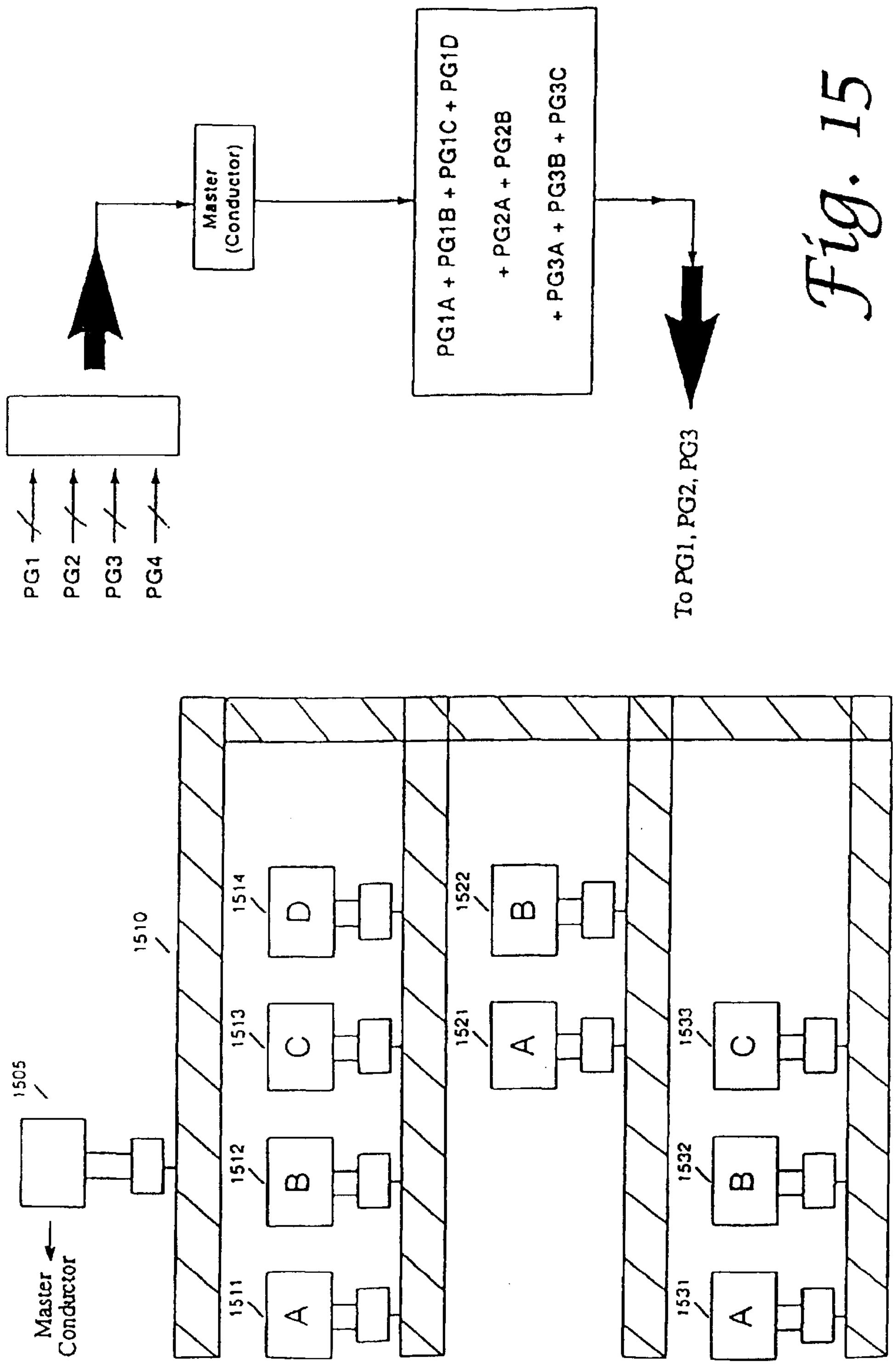
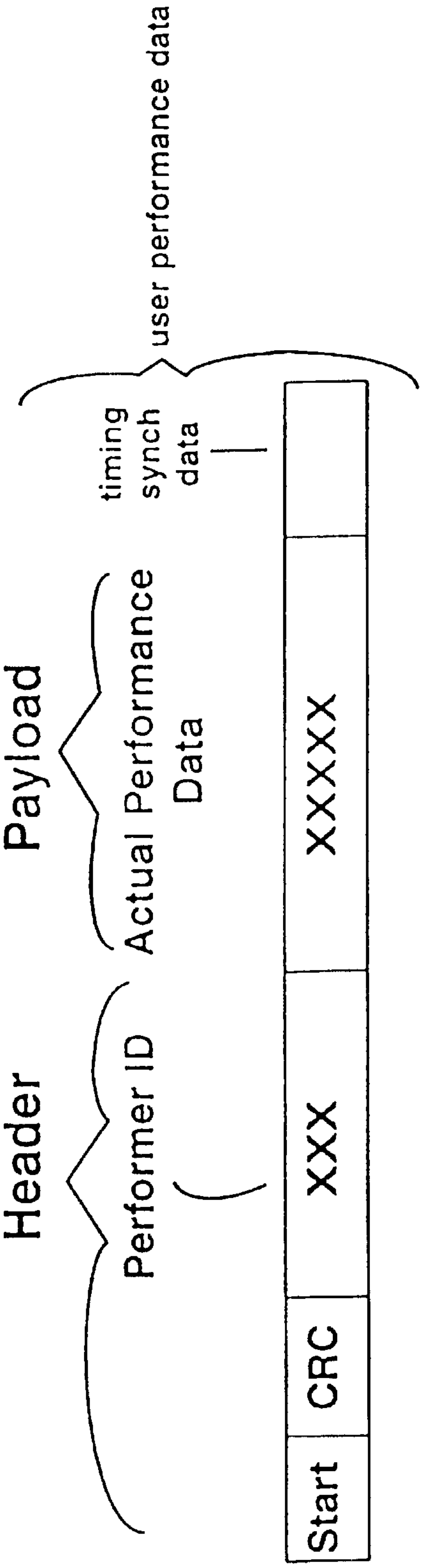

PG1
PG2
PG3
PG4
Master (Conductor)
PG1A + PG1B + PG1C + PG1D + PG2A + PG2B + PG3A + PG3B + PG3C
To PG1, PG2, PG3
Master Conductor
1505
1510
1511
1512
1513
1514
1521
1522
1531
1532
1533
A
B
C
D

Fig. 15

Fig. 16


user performance data
timing synch data
Payload
Actual Performance Data
Header
Performer ID
Start
CRC
XXX
XXXXX

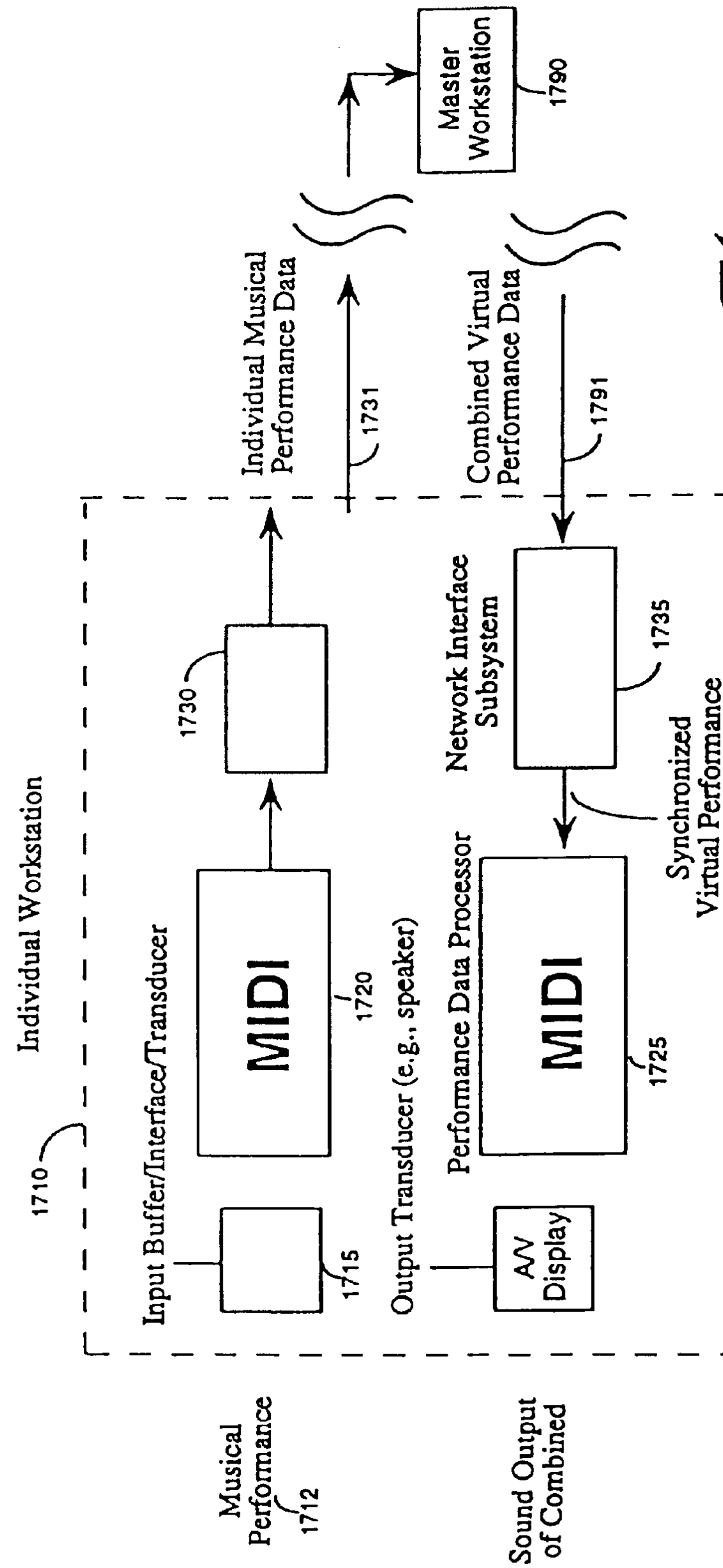
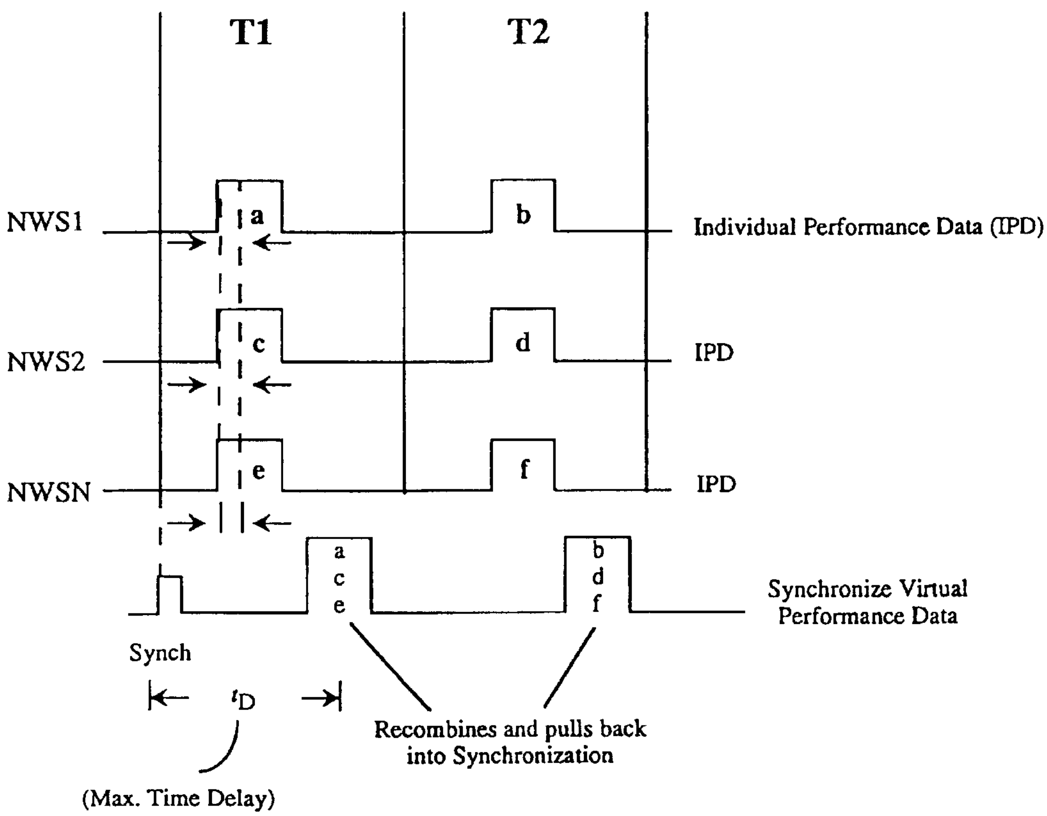

Musical Performance
1712
Sound Output of Combined
Individual Workstation
1710
Input Buffer/Interface/Transducer
1715
MIDI
1720
1730
Output Transducer (e.g., speaker)
A/V Display
Performance Data Processor
MIDI
1725
Network Interface Subsystem
1735
Synchronized Virtual Performance
Individual Musical Performance Data
1731
Combined Virtual Performance Data
1791
Master Workstation
1790

Fig. 17



a, b, c, d, e, f, = data and timing synch info

Fig. 18

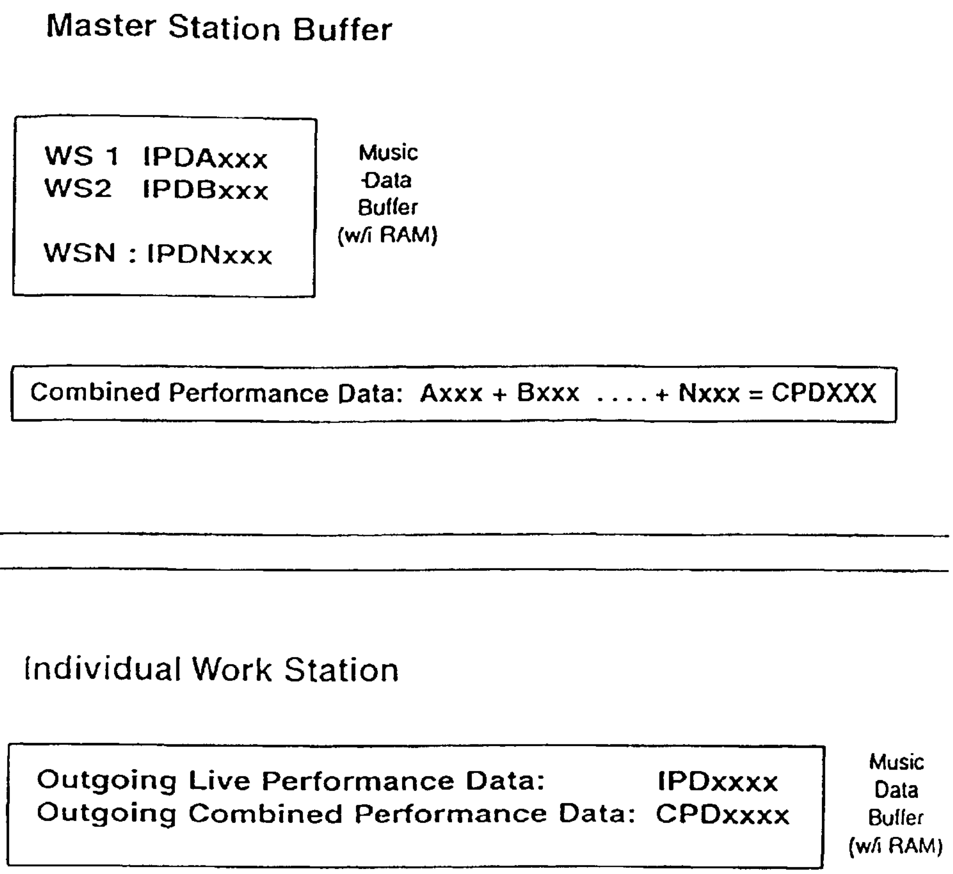

Master Station Buffer
WS 1 IPDAxxx
WS2 IPDBxxx
WSN : IPDNxxx
Music Data Buffer (w/i RAM)
Combined Performance Data: Axxx + Bxxx . . . . + Nxxx = CPDXXX
Individual Work Station
Outgoing Live Performance Data: IPDxxxx
Outgoing Combined Performance Data: CPDxxxx
Music Data Buffer (w/i RAM)

Fig. 19

MUSICAL COMPOSITIONS COMMUNICATION SYSTEM, ARCHITECTURE AND METHODOLOGY

This is a continuation-in-part application, under 37 C.F.R. §1.53, of pending prior application Ser. No. 8/677,469 filed on Jul. 10, 1996, for Multi-Dimensional Transformation Systems and Display Communications Architecture for Musical Compostions, now U.S. Pat. No. 5,728,960.

I. FIELD OF THE INVENTION

The present invention relates to the field of music. More particularly, the present invention relates to a display system for displaying musical compositions, either batch or in a real time environment, and processing and communicating user performances.

II. DESCRIPTION OF THE RELATED ART

Music is usually only available in the written form for one (or a fixed set of) performer/instrument types in a fixed key. Adaptations or variations of musical arrangements are complex and costly. Remotely located musicians are unable to effectively practice together. Small communities each with only a few musicians are limited to practicing with the few musicians they have.

Performers of music have many inconveniences to deal with. One such inconvenience deals with the composing, distribution, and utilization of music display presentation, traditionally sheet music. Another major problem relates to the inconvenience of scheduling and physical gathering of multiple musicians (including instrumentalists and vocalists), which when combined in their performance provide a musical ensemble or orchestra. For example, high school band practice requires that all students be available to practice at the same time at the same place (i.e., the school music room). However, this creates difficulties in that many students have other activities which conflict with band practice which is then incomplete. Additionally, when composing, musicians often will come up with an idea when physically not with another musician.

Musicians typically work from sheet music. When composing, they write the notes down on paper that has a number of staffs. If the musician transposes a composition from one key to another, the notes are also written down on the staff paper. The scores for different instruments must also be generated and written down. All of the scores are then copied for distribution to other musicians and/or music stores.

When performing, the sheet music must be found, for all parts to be played, manually distributed, manually set-up, manually handled (turn pages, etc.). There is also an unfulfilled need for quick access to a more comprehensive database of music for the performing musician, whether he is solo or part of an orchestra. Also, musicians often perform audience requests, and require access to sheet music for requested songs. Presently, there are various combinations of songs compiled in "FAKE" Books, usually by category (e.g., rock, country, blues, big band, etc.). This is only of limited help. Furthermore, the use of paper sheet music is cumbersome and inconvenient; pages often get damaged or lost, and indexed access is poor and slow.

This method of composing and distributing music is inadequate when the music is used by a band or orchestra that requires hundreds of copies. If the conductor desires the piece to be played in a different key or certain sections of the music edited to suit the conductor's tastes, the composition

must be rewritten and the new transposed copy distributed to the band or orchestra. This is a very costly, time-consuming, and laborious task if the orchestra has a large number of members.

Additionally, if the composition does not have a part for a certain instrument, the conductor must generate the required part from the original composition. After the score for the required instruments has been generated, the parts must be copied and distributed to the individual musicians. This, again, is a very costly and laborious task if the band has a large number of musicians requiring different parts. There is a need, therefore, for a more efficient way of transposing, editing, and distributing music scores.

Over the past many years, great advances have been made in the electronic input, storage, and display of music. Electronic bands and orchestras are constructed using computers and MIDI equipment. Programs exist for personal computers (e.g., Apple Macintosh, DOS, and Windows machines) for an individual to use the computer for transposing music, composing music. Programs also exists for automatically inputting music from direct performance (such as directly from a keyboard, electronically through MIDI converters (such as for string instruments), via pickups and microphones, and sequencers, tone generators, etc.) To generate digital data and/or music notation.

Musicians often perform both pre-planned and ad hoc compositions during the course of a performance. It would therefore be desirable to have the ability to access a large database of musical compositions on demand. It would also be desirable to permit communication and synchronization of a music presentation to multiple performing musicians who are playing together. It would also be desirable for a performing musician to have his or her performance of the music input onto an individual music workstation, and stored, and analyzed by an automated system, and/or communicated to one or more other networked (remote) individual music workstations.

SUMMARY OF THE INVENTION

The present invention encompasses a musical presentation system. In one embodiment, the system enables one or more users to select a musical composition, and perform the selected musical composition at each of a plurality of individual music stands, independently capturing the performance of a respective user and communicating the individuals performance data to a master workstation (which can be standalone or one of the networked individual workstations), which combines the plurality of individual workstation performance data into a composited combined performance data and communicates said combined performance data back to all of the individual workstations wherein the individual workstations provide for audio (and/or vide and/or audiovisual) output representative of the combined performance data (which represents the musical performance inputs for all of the communicating plurality of individual workstations). The time between the users performing the segment of music and that same user hearing the audio presentation of the combined data is less than the time interval detectable by a human being. In a preferred embodiment, the plurality of individual workstations collectively provide for synchronized display presentation of a selected music composition's presentation, and provide for output of individual performance data representative of the musical performance of the user corresponding to the display presentation. Timing-synchronization is also provided for to permit synchronization of the display presentation of

the plurality of individual workstations, and for synchronization by the master workstation of the plurality of individual performance data to construct the combined performance data. In one embodiment, the master workstation generates a synchronization signal that is communicated to all the individual workstations from the master workstation. Other synchronization structures are also equally acceptable, such as embedding timing synchronization data within the individual performance data.

In another embodiment of the present invention, a musical presentation system enables a user to select from one or a variety of musical compositions, control the adaptation of the selected composition, and distribute the edited version efficiently in a paperless environment. The system and process of the present invention also provides means for receiving music from a number of sources. The user selects the desired musical composition from the source. The desired composition is displayed and/or stored in the system's memory for further processing by the system prior to display and/or distribution.

In accordance with one aspect of the present invention, each of the music workstations in an intelligent music composition communication architecture provides for musical information, to be distributed for a video or visual presentation of music in a user-friendly notation, and/or provides an audio presentation that can be selectively tracked and synched to the video presentation and/or tracks and synchs the displayed video presentation to a live performance, etc.

In still another embodiment, the system includes a user input device enabling selection of the musical composition, and optionally, permitting any user specified editing desired in the composition, and, in a preferred embodiment, permitting user selection of parameters (such as the musical key in which the composition is to be played). The user can then instruct the system to transmit the newly generated music scores to one or more display subsystems (such as CRT's, LED's, LCD's, etc.), or to other systems. In the preferred embodiment, these displays take the form of liquid crystal displays built into music stand based systems, also referred to herein as display stations or workstations.

This invention also relates to a musical presentation and/or communication system, and more particularly, to a system which permits musicians to view the score or other audiovisual or visual-only presentations of a musical composition, to permit the musician/user to perform the musical composition on the instrument of choice, as selected by the user, and in the key of choice, as selected by the user.

In accordance with one aspect of the present invention, one or more music workstations are provided, consisting of a video presentation means, such as a display screen (CRT, LCD, LED, Heads Up Display (HUD) etc.) in conjunction with a computer-based system which in one embodiment stores a database of songs and music which can be utilized by the musician/user of the system.

In accordance with yet another embodiment of the present invention, there are provided numerous music workstations, such that different or similar instruments can each select a respective portion of a song to be performed, such that all musicians performing the same musical piece are provided musical presentation or representation in the same key to permit the playing of the music together. In a preferred embodiment, the system is capable of locking into a particular key (and/or instrument type) responsive to input variables (such as can be provided via an input device such as a microphone or keyboard, or voice recognition, or camera) to determine the desired key to be played in. In a preferred embodiment, the user can select an auto-transpose mode where all music is thereafter automatically transposed. The transposition can take place at a master workstation and then be communicated to the individual workstations. In one of the illustrated embodiments, the transposition of the music takes place locally at the music workstation which provides local intelligence. An original musical composition, such as selected from a stored database of a library of music is then transposed in accordance with transposition rules. Many options are available, and various transposition rules and methods are well known and documented and in use on numerous products, such as keyboards which have built-in capabilities for transposition of music, as well as computer software which provides for transposition and notation of music.

In accordance with an alternate embodiment, the user connects to a remote database via wireless or wired communication to permit downloading to the local computer of those musical pieces which the user has selected for performance. The user music terminal, or the central computer, can receive the transposed (derivative composition) version or can receive an unmodified (original musical composition) version, which it can then display and/or convert and transpose music as necessary for each instrument and/or key.

In another alternate embodiment, a user can prearrange for downloading of selected compositions via a remote connection service, where the music user terminal can include a non-volatile storage memory permitting the storage and replay of all requested compositions. Alternatively, a central server can be provided, where multiple music end terminals share a single central controller computer, or each have their own computers which share in a central server computer or with each other in a distributed architecture.

Alternatively, a non-volatile storage structure, such as a CD-ROM, can contain a database of music which can be selected from for transposition in accordance with the present invention.

The present invention provides a music communication architecture and methodology that permits the synchronizing of music display presentations for multiple display stations performing the same musical composition. Bands and orchestras can be constructed using multiple independent music workstation display whether at one site or remotely distributed. In one embodiment, the music display presentations provides one or more of the display of the musical composition, performance by the user, and the output presentation for the combination of the individual performance data for a plurality of individual workstations. In one embodiment, a master workstation is responsive to the individual performance data from the plurality of individual performance data and provides means for synchronizing and compositing the individual performance data from the plurality of the individual workstations, and providing a presentation output (audio and/or video) comprising the combined virtual performance.

It is a further object of the present invention to permit the comparison of a performer's performance parameters, such as parameter signals obtained via a microphone and/or camera, of the performing artist's performance or execution as compared to the stored and displayed music. The comparison includes the pitch, timing, volume, and tempo etc. of the music (such as through audio recognition) and critique the artist's physical movements (e.g., proper finger position, etc.) through visual recognition. In a preferred embodiment, the music workstation system provides the performer and/or

a conductor with a presentation performance feedback indicating the quality of the performance as compared to the stored or displayed music, such as any errors, where they occurred, etc.

It is a further object of the present invention to provide a system whereby any displayed music can be transposed (e.g., to a different key, or converted to include different or additional different instruments and voices than that in which the sheet music is originally displayed).

It is a further object of the present invention to provide automated modes of intelligent operation of the music workstations, and to provide responsiveness to multiple forms of user input.

These and other aspects and attributes of the present invention will be discussed with reference to the following drawings and accompanying specification.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1A** and **1B** show a music presentation system in accordance with the present invention;

FIGS. 2A–2G show flow charts of the processes in accordance with the present invention;

FIG. **3** shows one embodiment of the display for the music display workstations and input devices in accordance with the present invention;

FIG. **4** shows a shared music database and stand alone workstation embodiment in accordance with the present invention;

FIG. **5** shows a music communication system in accordance with the present invention;

FIG. **6** shows a master workstation and slave workstations in accordance with the present invention;

FIG. **7** shows an alternate embodiment of the present invention using one or more of the workstations coupled to a master controller and music database;

FIG. **8** shows a marching band environment in accordance with the present invention;

FIG. **9** shows a person outfitted with a sensor body suit in accordance with one aspect of the present invention;

FIG. **10** shows a movement and pattern recognition system in accordance with one aspect of the present invention;

FIG. **11**A illustrates a flow chart for an alternative embodiment of the operation of the automated mode "A Mode" **240** of FIG. **2**A, alternative to that illustrated in FIG. **2**C;

FIG. **11**B illustrates the process flow for an alternative overall operation relative to FIG. **2**A of a music composition communication workstation in accordance with the present invention, wherein steps **200**–**250** of FIG. **2**A are redefined to show an overall operation which also encompasses a specific networked mode A Mode **5**, as further illustrated in FIG. **12**;

FIG. **12** illustrates the process flow for the networked virtual performance mode **1150** of FIG. **11**B;

FIG. **13** illustrates the process flow for automated mode **6** corresponding to process step **1153** of FIG. **11**A, directed to synchronizing the display to the performance, to resynchronize the display of the music to account for performer error;

FIG. **14** illustrates a communications architecture in accordance with the present invention, where each of the individual music stands **1410** receives a music input **1411** and provides performance data output **1412** coupled to and communicating with a master workstation which generates an output of virtual performance data **1451** responsive to compositing the plurality of individual performance data signals which virtual performance data **1451** is communicated back to all of the plurality of individual workstations **1410** which provide audio output responsive thereto;

FIG. **15** illustrates one example of data flow communication architecture for a plurality of physically separate remotely located locations, such as a teacher/master conductor/server location and each of a plurality of locations that provide communication of performance data for users of the individual workstations at each of those locations, wherein timing information is utilized by the master workstation to reconstruct and combine all of the individual performance data into a combined virtual performance data output coupled back to the plurality of individuals workstations which responsive provide audio output;

FIG. **16** illustrates a data word structure compatible with one embodiment of the present invention;

FIG. **17** illustrates a block diagram for a workstation (generally shown in FIGS. **5**–**7**) and further comprising a network interface and a MIDI performance data processor,

FIG. **18** illustrates a timing diagram showing the synchronization timing of the architecture as illustrated in FIGS. **14** and **15**, and data structure illustrated in FIG. **16**, and showing the composited synchronized virtual performance data and the multiple individual performance data; and

FIG. **19** illustrates one example of a memory work space structure for the individual and master workstations in the virtual performance mode, in accordance with the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

While this invention is susceptible of embodiment in many different forms, there is shown in the drawing, and will be described herein in detail, specific embodiments thereof with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the invention to the specific embodiments illustrated.

In accordance with the teachings of the present invention, a system and methodology are provided for music presentation and communication. Musical compositions can be input to the present invention from any one or more of multiple sources, such as from prestored score images, live microphone, direct input from musical instruments or vocal direct performances, scanning in of existing printed score images (optically character recognized), cameras, visuals, etc. These inputs by the system are used in the selective storage, composition, communication, and presentation of the musical system of the present invention. The system can generate additional material automatically, or permit a user to modify, communicate, display and/or reproduce the musical compositions.

Modification can be performed on rhythm, primary key, individual notes, chords, etc. The vast store of musical information stored in digital notation format and/or any video format, can be broadcast (analog or digital) to a local music workstation or a master controller, which can also be a local workstation. The master controller can be a stand alone unit, or act as a server as well as its own stand alone unit, or simply as a server to a plurality of other stand alone units. However, in the minimal configuration, only a single musical user station is needed.

In one preferred embodiment, the workstation is provided as a music stand where the display presentation is a liquid crystal display (LCD). The LCD that can provide

monochrome, gray scale or high quality color displays, depending on design and cost constraints and desires. Other display types can also be used. A touch-screen input can provide for simplified and adaptive user input selections. An optional built-in metronome function can also be provided for display presentation audio and/or video. A subsystem can also be optionally provided to permit the music to be audibly reproduced at the workstation through a speaker or headphone jack or other output.

It is well known in the art to convert user analog audio input into a digital format, ranging from straight Analog to Digital (e.g., A/D) conversion to processed data conversion to encoded digital music data, such as MIDI. Examples of MIDI include guitar input or other stringed instrument input through microphones or directly to MIDI-converters, or voice/non-pickup instruments through microphone converted to MIDI-input, or keyboard MIDI-input. Such input systems are commercially available from numerous companies for numerous types of interfaces at numerous interface levels. Similarly, numerous A/D converter subsystems are commercially available at chip and board solution levels (such as from Analog Devices Corporation and from Mattrox Systems).

In accordance with one aspect of the present invention, the multi-dimensional music transformation system of the present invention also enables a user to select one or more musical compositions from a larger database from a plurality of musical compositions. The database can be stored locally within the workstation, on site, or remotely stored and transmitted to the user (such as over cable, wire, telephone lines, wireless (such as radio frequencies)). The user can also optionally edit the selected score of the composition (such as changing the key and/or any note and/or timing, etc.) to suit his or her taste. The score (altered (the derivative composition) or not (the original composition)) can then be transmitted to one or more displays such as liquid crystal or CRTs in the music stands of the band or orchestra. The present invention, therefore, provides an efficient, paperless solution to communicating, presenting (displaying), and optionally one or more of transposing, editing, inputting, comparative testing-teaching, conducting, and disseminating music to one display or a large number of displays. Each display can have the same, or a different, unique, customized presentation of music notation as appropriate per selection, responsive to a set-up by a system, automatically per predefined parameters, and/or to user input. The score can also be printed out if a hard copy is desired.

As illustrated in FIG. 1, the music is stored, such as on a large hard drive or CD ROM jukebox, in a digital format as a music library (120). The music library (120) is coupled to a processor subsystem (115). Coupling can be wireless or cabled such as through a shielded cable, fiber optic conductor, switched connection (such as via phone lines), local, or remote. The processor (115) has the local storage capacity (e.g., semiconductor memory, disk storage, etc.) to hold the digitized version of the music composition transmitted to it on request from the library (120). The music library can be local or proximately remote from the rest of the system.

In a wireless embodiment, the music library (120) is coupled to a communications subsystem (such as a radio frequency transmitter) (125) that transmits the contents of requested compositions from the remote music library (120) to the processor (115) through the antenna (104) of the transmitter. The antenna (102) at the receiver picks up the transmitted signal and the receiver conveys it to the processor (115). This embodiment enables the music library (120) to be remote and located at a great distance from the requesting site. The communications subsystem (125) can be a transceiver for bidirectional wireless communication, or a transmitter for one-way wireless communication (such as where the requests are otherwise communicated to the music library subsystem (120), such as via a wired connection).

As illustrated in FIG. 1A, a system controller, in the form of a music stand (105C) with a liquid crystal display, is used by an operator (e.g., performer, conductor, etc.) to select one or more musical compositions. FIG. 1A illustrates two types of music workstations stands. The workstation stand (105C) provides certain optional features for a more full-featured stand, including as illustrated, speakers (140) both wireless and wired communications capability, and as illustrated, shows the processor with memory (115) as an external separate component. The music stand (105P) shows the integration of the processor and memory into the music stand itself, and also shows both wireless (antenna (101)) and wired connection (port (107)) to permit network communication. Alternatively, the conductor stand (105C) could have all or part of the features integrated into the music stand (105C). Depending on the function for which the music workstation stand will be used, some or all of the features can be provided for that stand to minimize costs or optimize versatility. For example, in one situation, only the teacher or conductor needs the full-featured, full-powered music workstation. In that case, the performers or students do not have a full-feature workstation, but rather a scaled-down version of the workstation stand. In the preferred embodiment, a user input device (110) (such as a touch screen, microphone, keyboard, switches, voice recognition system, visual recognition system, etc.) is coupled to the processor in a wired (such as over a cable or fiber optic link) or wireless (such as over an RF link or infrared link) manner for workstation stand (105C), or directly to the processor, where it is built into the system controller as workstation (105P). The user can select an original musical composition from the touch screen of the liquid crystal display (135). The processor responds by storing that composition in the memory (115) of the local workstation of the user as requested.

Using the touch sensitive LCD (135), the user can now create a derivative musical composition. The touch sensitive LCD allows the user to enter the musical key in which the original composition will be played, edit any notes desired, and select the instruments and parts that will be playing the composition. The composition as originally composed, and the derivative or modified composition can be played back to the user over speakers (140) so that he or she may listen (e.g., such as to observe how the changes will sound) while optionally permitting simultaneous viewing of the score on the presentation visual display. Once the score has been designated (e.g., selected, edited, etc.) to the users (e.g., conductor's) taste, the appropriate portions (e.g., by musical instrument) of the scores can then be transmitted for (optional storage and) display to the respective associated individual music workstation stands of the band members.

No mixing?! maybe yes but communicating with a centralized device

In a preferred embodiment each stand has an input device (110) that permits the user of the stand to select which instrument will be using the stand. (As discussed above, this input device can take the form of a touch sensitive screen or a number of buttons or switches or voice or audio recognition, etc.)

In the preferred embodiment, each individual music workstation stand (105) can be directly and/or remotely programmed to addressably receive (and optionally to locally convert) and display the music score that is intended for the respective instrument type (user type) that will be

using (is associated with) the stand. As an example, the user of the stand (or a conductor) can input their selection of saxophone into the user input device (110) of the workstation stand (105C), to program that workstation stand (105C) only to receive the musical score for the saxophone (see FIG. 3). Then, the musical scores for all selected parts can be independently broadcast to all connected workstation stands, with each individual workstation stand individually distinguishing and accepting only its part. Alternatively, each workstation stand can be individually addressed for separate broadcast reception of its own respective selected part. Additionally, the user of the stand can program the user input to select a musical part of a selected musical composition (e.g., saxophone first chair) and receive only the musical score intended for that chair. This same procedure can be followed for other instruments within the band or orchestra. Alternatively, a single music composition can be broadcast to all workstations, where each workstation has local intelligence (processing and storage) to permit local conversion for display at each workstation for the selected instrument for each workstation.

For wireless communications, the individual music workstation stands (105) are comprised of receivers (or transceivers where bidirectional communication is desired) and antennas (101, 103) for receiving (or transceiving) the radio frequency information from (and to) the master workstation (such as for the conductor). The music stand also has a display (such as an LCD (135)) for displaying the musical score intended for that stand.

Referring to FIG. 1B, the music workstation stands can either be identical or broken down into conductor stands and performer stands. A conductor stand (105CON) may have more functions and control than a performer stand (105PER). A performer stand (105PER) might only have the ability to receive and display musical scores, whereas the conductor stand (105CON) has the ability to select the musical score, change the key of the musical composition, and perform other tasks only a conductor would be permitted or required to do.

master & slave interchangable

In one embodiment, an RF antenna for the stand (105) can be built into the stand itself Alternatively, instead of using RF, the performer's stand can be linked to the main (e.g., conductor's) stand using infrared, fiber optic cable, shielded cable, or other data transmission technologies. As discussed above, the communications link can be bidirectional, such as to facilitate requests and responses to facilitate the feedback of performance parameters or such that any workstation can be a master or slave, or used in combinations.

FIG. 2A illustrates the overall operation of the music composition communication workstation. It begins by starting up the system (200). The system then provides a menu (201) that allows the user to select a listing of available music compositions. The user then selects one or more compositions (210). If the user selects one from the menu that is locally stored, it directly retrieves the information. Alternatively, if it's not something locally stored, the system couples (e.g. will dial up or go through a database or network) to a remote storage site and requests and receives the selected compositions.

Any changes that are desired to the composition can be selected at the next logic block (215). If there are changes (such as to the key, or note editing, or selection of form of display or instruments), then those can be accomplished as illustrated at blocks (255) to (285).

If no changes are desired, the musical score for the composition that is selected is broadcast, transmitted, or otherwise transferred to the workstation music stand (220). It is internally stored in the local workstation music stand. Next, the score is displayed (225) on the workstation display (e.g., LCD or CRT) or a video projection system. The display can also be part of an integral stand-alone workstation or an interconnected group of components including a personal computer (such as Macintosh, or DOS or Windows PC).

The display mode selection is then made (230). This permits selection of an operational display mode, not simply choosing the resolution or color. The two main choices in the preferred embodiment are a manual mode (250) and an automated mode (240). In the automated mode selection (240), there are many sub-modes or options, such as the operational mode that permits the performer or user to do their performing without having to tend to the selection of the portion of the music to be displayed or the turning of pages. In the auto performance mode as shown on LCD (135P), there is provided the simultaneous displaying of the selected musical composition, and a display representative of the audio performance of the user, and a divergence signal or divergence data representative of analyzing the performance, preferably in approximately real-time.

FIG. 2B illustrates the manual mode (250), which provides for user manual selection of functions (252). There are many functions that the user can select, even in the manual mode, such as hitting a button or a touch screen to cause the turning of the page of the display. Another function is to go back a page or to scroll forwards or backwards. For those who are vision impaired, another function can increase the font size of the music presentation.

Thus, there are many manually selected functions that can be provided. While the manual mode can have automated functions selected, it is distinguished from the automated mode where control is partially pre-defined without user assistance. In the manual mode (250), the user selects any and all features that are going to be provided (some of which can be automated). The selected function is then processed (256).

Next, any ongoing needs are processed (257). These needs can include any overlapping automated function (not otherwise inconsistent with any other selected function).

Referring to FIG. 2C, the operation of the automated mode "A Mode" (240) is illustrated. First, the user selection of the desired automatic mode is detected and responded to, illustrated as the auto-advance mode (242), the training mode (244), the performance mode (246), or any one of a number of other modes (248) as is described in further detail hereinafter. For example, auto repeat mode can be selected by designating the start and stop points, and the number of times to repeat a "looped" portion (or portions) of the displayed musical composition. Marching band mode (auto-advance based on metronome function, conductor control, etc), auto-compose mode, and many others can also be implemented. The order of selection of auto-advance, training, or performance mode is arbitrary, and the user can alternatively decide from a menu where all are simultaneously presented as choices.

The display can advance the music by page option, or by a user selection of one of many options (e.g., scrolling, tablature, video graphic tutorial display, etc.).

Referring to FIG. 2D, the automated mode 1 for auto-advance operation (242) of FIG. 2C is illustrated, where the user has selected an auto-advance performance mode. In this mode "A Mode 1" (271), the system tracks the performance by the user of the composition to the score (272). Perfor-

mance refers to the actual performance by an individual person (or people) who is (are) reading the musical score upon which the performance is based. Whether that score is in tablature format, staff and clef and note notation, or some other format, the system generates appropriate signals to permit comparison of the user's performance to the musical score.

Based on a comparison, a decision is made pursuant to selection criteria programmed into the system (such as the rate at which the piece is being played, the time signature, the tempo, the rhythm, and the advancement of the music on the available display), the display presentation is advanced (**274** and **278**). In some cases, the music might move backwards, such as with D.S. Coda. The presentation of the display tracks the performance to permit smooth, uninterrupted playing or singing. The capability can be provided for the user to over-ride this auto-advance, such as for practicing where it is desired to keep going back over sections. In this case, a user over-ride option (**276**) is permitted to alter the automated operation. Upon cessation of user over-ride, the system can be programmed to stop, to automatically return to the regular auto-advance mode, or to process other auto-modes (**270**) of FIG. **2**C.

Referring to FIG. **2**E, the automated mode "A Mode 2" (**244**) operation of FIG. **2**C is illustrated corresponding to the training mode. In this mode, the system tracks the performance (**280**) of the individual user to the composition score, primarily for the purpose of permitting a critical analysis and comparison of the performance to the score (**282**). This analysis determines divergence from the selected musical score, and reveals errors or deviations from desired performance goals (e.g. match of timing of notes, duration of notes, pitch of notes, etc.), and to display those errors (**284**) (such as by audio or video means). Predefined performance goals provide the knowledge basis for expert system based analysis.

The system can then generate a graded score (**286**) indicating errors, and can present it in numerous formats such as histograms, frequency of errors, spacing of errors, etc. Identification of when the errors occur (e.g., only when going from slow to fast, or fast to slow), absolute position within the score and so forth, are also tracked and reported. Other expert system rules can be provided by music teachers which give the necessary parameters for modeling expert system reasoning, as well as guidance and suggestions on how to correct problems such as via display text, graphics, audio, etc.

The comparison of the performance to the score in the training mode is for the purpose of detecting the performer's compliance to parameters (such as the tempo, rhythm, filter, parameter, pitch, tonality, and other features that are adaptable or can be modified by performers). This parameter information is available and published in numerous forms. Thus, having provided this core set of parameters, the system can thereafter perform the training automated mode.

As illustrated in FIG. **2**F, automated mode 3 "A Mode 3" is the performance mode (**246**). In this mode, the operation is as in automated mode 1 (auto-advance mode) except that no user over-ride is permitted. Its primary purpose is to accompany the performer during the entire performance of a score as an automated page turner. The tracking of the "page turning" to the performance can optionally be based on inputs or criteria independent of a performer's actual performance input (e.g., microphone), such as a built-in metronome clock, a central control (e.g., a conductor or special user input), etc. Additionally, performance characteristics can be tracked, computed, and reported as in the teaching and training mode. Training feedback can optionally be provided real-time, or subsequent to completion of performance, to assist the performer as in the training mode. Alternatively, the score can be presented in a moving score mode (e.g., vertically, horizontally, or otherwise) or linear presentation as opposed to a real page turning display.

FIG. **2**G shows the operation of automated mode 4 ("A Mode 4") which provides for the processing of other automated functions selected by the system. These modes can include conductor mode, karaoki mode, etc.

In conductor mode, a conductor can control communications of signals to his or her performer (such as "increase volume", or "increase tempo", or "play staccato"). Icons can be provided where the conductor simply touches a touch screen (or other input mechanisms) to supplement his hand and body motions to permit more effective communication with the performers. Alternatively, as illustrated in FIGS. **9** and **10**, in a more advanced system version, the conductor's movements are first learned by a monitoring system, based on user definition and assignment of meanings for movement to provide an expert knowledge database.

This system provides for tracking of movement input such as in FIG. **10** via video camera (**1005**) input of the conductor (**1015**) against a backdrop (e.g., blue screen) (**1010**) is processed by video processing unit (**1020**), or, as shown in FIG. **9**, via body glove technology (gloves (**935**) or sensors (**944**) or sensor clothing (**940**) or head or eye movement tracking sensor (**930**) (such as used in virtual reality, flight simulation, avionics equipments (such as jets and space travel), and sports players for analyzing movement) to provide the necessary movement input. This movement input is analyzed utilizing the expert knowledge database to automatically generate a display (video and/or audio) to provide local visual and/or audio reinforcement on the local display (such as overlaying on a then unused portion of the music score display as a picture in a picture) to permit audio and video reinforcement of the conductor's body language. Thus, "a hush" body language signal that is directed towards a particular section of the orchestra would automatically be interpreted to cause the system to indicate, and only on that particular section's respective displays, a message (e.g., big face with a finger in front of it making a hush sound with a "hush" sound simultaneously output from a speaker). The conductor mode provides many benefits to performance and communication.

For all these automated modes (e.g., A Modes 1, 2, 3, 4), training feedback can be provided real time or subsequent to performance at either or both of the perforner's workstation and a second (e.g., teacher's) workstation.

The advantages of electronic music composition, communication and display are many. In addition to those discussed elsewhere herein, a capability exists for expert system based artificial intelligent type assistance where the expert system assists in many of the functions performed in musical composition and performance. For example, in the Auto-Compose Mode, if the words need to be changed to match the meter, equivalent terms can be chosen from the many sources such as thesaurus, dictionaries, rhyming dictionaries, encyclopedias, etc., to assist as well. Phrases from poetry, selected and indexed by content or topic can be re-expressed to create new works. Drum and rhythm section accompaniment can be expertly suggested, as well as harmonies, melody lines to accompany chords, chord progressions to accompany melodies, harmonies to accompany a melody, and suggested musical instrument groupings to support a particular sound, rhythm, style, tonal quality, etc.

The expert system can be built from commercially available technology, including component hardware systems with supporting software, as well as commercially available software packages which operate on commodity-type personal and business computers such as the Macintosh by Apple Computer, Windows and DOS machines based on the X86 and Pentium processor technology of Intel, technology based on the Power PC and 68XXX processor by Motorola, DEC PDP-11 technology, Sun workstations, etc. Custom microcomputer or DSP based system architecture on a chip can also be constructed, as well as ASICs, custom or semi-custom logic.

The system can be designed to take advantage of expert system design knowledge. A database of rules and facts are provided, and accumulated over time by the system in a self-learn mode. The expert system itself has the necessary logic to probe the user, monitor the performance, and apply the rules to provide feedback and reports to the user of skill level, errors, automated performance display, etc., starting with a base defined set of rules, instructions, and a knowledge database specific to music.

The form of the musical score communication can be easily shaped to fit needs. One example is MIDI (Musical Instrument Digital Interface standard) which has advantages such as of bandwidth of storage used, is widely available commercially, is standardized, etc. However, signal processing, text, icon-based, object based, and various other forms of storage, user interface, and processing can also be applied to more specific applications of product.

FIG. **3** illustrates one embodiment of an LCD display used for input control and for displaying the information from the processor and memory. In the preferred embodiment, this LCD is a touch sensitive screen enabling the functions associated with each displayed button to change, and also for the displayed buttons to be moved around the screen, depending on the function to be activated. The musical score may be edited by the conductor, such as by touching the individual note after which he is presented with a number of notes to replace the touched note. The lower portion of the screen displays instruments from which the conductor can select which instrument will be playing the composition. After a button on this screen has been touched, a number of sub-screens may come up, each with their own individual touch sensitive areas and functions to be activated by those areas. Alternatively, in addition to or instead of the touch screen, the system can provide input via separate key switches, voice recognition, etc.

As an example, if the conductor touches the transmit key on the main screen, he will be presented with a screen showing all of the instruments that he has selected for that piece and a button labeled "ALL". He may now transmit to each individual music stand or by depressing the "ALL" area, transmit to the entire orchestra.

The music library can be contained ("stored") on non-volatile storage either locally or at a remote central site containing the entire (or a subset) database of all possible music (that is then downloaded to local storage on request, either real-time at performance time or in advance.)

Alternatively, the music library can be provided on storage medium that can be easily transported and used on site locally with the presentation system. Thus, for example, disk drives, cartridges, FLASH RAM cards, plug-in memory modules, or a CD-ROM or multiple CD-ROMs in a CD-ROM changer can be used to store and contain massive data libraries on musical compositions. While this would be a more expensive route than shared use of a central library, requiring each musical group to obtain libraries on all possible compositions they may want, it has the advantage of speed, flexibility, no need for communication with a separate remote source, and creates a whole new mass marketing area (such as for CDs or Digital Audio Tape (DATs)). Another way of utilizing this technology is to maintain a history of music used, either with the remote music library or local music library. This could be done for many reasons, including copyright royalty assessment, determining a history of musical performances and requests for future use in determining performance itineraries, etc. Alternatively, a hybrid of locally stored and centrally shared libraries can be utilized to optimize cost, speed and flexibility benefits.

In accordance with another aspect of the present invention, each display workstation can also provide the ability to convert performed musical compositions into annotated musical compositions, generating the appropriate musical notation (e.g., staff, tablature, MIDI), notes, time signature, key, instrument, or user type, etc.

The display workstation can be implemented as a totally self-contained workstation, where each workstation contains its own processing sub-system, optional communications interface (such as wireless or cable) for network use, input/output interface including one or more of a user input keypad, a speaker, a microphone, joysticks, push buttons, etc. Each of the stand alone workstations can then operate with a local database or couple to a shared music database as illustrated in FIG. **4**.

The stand alone workstation(s) (**105**), are coupled to the shared database interface (**405**), and can either couple remotely (e.g., via phone lines) to the remote shared music database or to a local shared or dedicated music database (**410**). The shared music database (**410**) can either be primarily a storage means (e.g., hard disk or CD-ROM), or can include a processing sub-system (**420**) for local intelligence. In one embodiment, the stand alone music workstation includes the shared music database (**410**) and interface (**405**), non-volatile local storage medium for the shared databases (**410**), and a local processing subsystem (**420**), and can operate completely stand-alone. In an alternate embodiment of this stand-alone device, the shared database interface is contained in the stand-alone workstation (but not the shared music database or processing subsystem), and provides capability for communication with a stored database (**410**) remote from the stand-alone device.

In either of these embodiments, an alternate additional embodiment provides capability for each stand-alone workstation to function as a master stand-alone, or a master or slave workstation within a workstation set including multiple stand-alone workstations, wherein one is designated master and the rest are designated slaves. The slave workstations in this configuration receive communication of music compositions to be displayed from the master workstation, thereby permitting one shared music database to be communicated among all workstations which are a part of the group. It is to be appreciated that the shared music database function can be distributed in many different ways among the workstations, or separable from and independent from the workstations. The choice is simply one of design, and the illustration herein should not be taken in a limiting manner.

In one embodiment the master workstation has complete control over the slave workstation. Anything displayed on the master workstation is also displayed on the slave workstation. It is also possible for the user to mask certain

portions of the display of the master workstation before it is displayed on the slave workstation. In this manner, the conductor, using the master workstation, can transmit to the slave workstations only that information that is required by the orchestra members.

In an alternate embodiment, the slave workstation communicates performance parameters or deviation signals to the master workstation, for error analysis feedback.

In accordance with another aspect of the present invention, means are provided wherein a plurality of individual workstations are coupled together in the network configuration to provide for networked communication of musical performance data wherein each of the individual music workstations provides for capturing the performance data for a users performance and communicating that performance data to a master or a conductor workstation which synchronizes and combines the plurality of individual workstations performance data to create a composite virtual performance data output which is recommunicated back to all of the individual workstations in approximately real time, so that the individual workstations can receive the composite virtual performance data and provide an audio output (and/or visual presentation) of the combined composite virtual performance data including all of the individual workstations users performances. While the networking can be used in conjunction with other features and embodiments of the present invention, including communication of musical compositions for display, and other musical performance data analysis and data communication, as well as inter-musician interpersonal communication, the networked embodiment of the present invention permits synchronized virtual performance thereby permitting multiple remotely located individual workstations to physically separately perform with the benefit of hearing in approximately real time the combined result of all the performances at the individual workstations with their own individual performance.

In accordance with another aspect of the present invention, means are provided to permit a user of the music workstation to accomplish a transposition of a musical composition in pitch, tempo, and otherwise. In a preferred embodiment, the lead voice or instrument can audibly indicate the key via the microphone input or via another type of input stimulus. The workstation can analyze the user input, determine the key, pitch and tempo for a musical composition being partially performed by the user, and adjust and transform the composition to be displayed in the new user desired key, pitch, tempo, etc., either solely for use on that workstation, or communication for use on one or more other workstations. In a networked version, this user input can also be communicated to other workstations for use by one or more of the workstations in transposing, or communicated to a master workstation, which transposes and rebroadcasts the transposed composition.

Alternatively, the user can input the pitch, tempo, and key via the user input (e.g. keypad, joystick, push buttons, voice recognition, playing of an instrument, etc.) and the system performs the transformation and displays (and/or prints out and/or audibly performs) the modified transformed composition for the user. Additionally, where a musical composition is written for one instrument and a different or additional instrument version is desired for simultaneous performance, the user can indicate the other instruments via the user input, and the system will generate the appropriate displays. The workstation can also provide an audio output of the transformed musical composition, either for the individual additional instrument or voice transform and present it, or for the composite of additional versions and the original version, to hear the blended piece.

Referring to FIG. **5**, a music communication system is illustrated comprising multiple workstations **(500)** each comprising a display **(510)**, user input such as a keypad **(522)**, a joystick **(524)**, push buttons **(525 & 526)**, a microphone **(527)**, and a speaker **(528)**. The workstation also includes communication interface means such as a wireless interface including an antenna **(531)**, or alternatively or additionally a wired or cabled communication interface **(540)**. Each workstation further includes a local microcomputer subsystem **(550)** that provides local intelligence and management of functions in the workstation.

In the networked embodiment, where multiple physically separate locations each having one or more individual workstations provide for communication of performance data from the individual workstations and presentation by the individual workstations of the combined virtual performance data at the individual workstation, to provide for a virtual performance. In this case, the communications interface would utilize slightly different structure, such as a phone modem (analog modem), a cable modem, ISDN as between locations, etc.

Communications interfaces of various types are well known and commercially available. At the present time, they are available for purchase at the chip, board, or system level. In fact, many single chip microcomputers include communications interface capabilities, wired or wireless.

The workstation further includes an optional musical instrument input **(562)** and a musical instrument output **(564)** that permit the coupling of a musical instrument via a musical instrument interface **(570)** directly to the workstation. Thus, a keyboard, electric guitar through appropriate input, or a microphone input through the interface **(570)** permits instruments or voices to be directly input to the workstation for direct input independent of the microphone **(527)**.

The instrument output permits coupling of the instrument input signal, either directly fed through or as modified by the workstation for output to the appropriate public address or amplification and presentation system or separate analysis system. The workstations are coupled either via wired or wireless communication to a processor subsystem **(580)** that includes a processor, non-volatile memory, read/write memory and an interface to a non-volatile storage medium **(582)**.

The processor subsystem **(580)** includes an appropriate communications interface, such as a communications interface **(540)** for wired interface or **(532)** for wireless interface including antenna **(533)**. The processor subsystem couples to a non-volatile storage medium **(582)** containing, among other things, application programs, transformation programs, and either a shared music library interface application program or the actual shared music library and access program.

As described above, the processor subsystem **(580)** and non-volatile storage **(582)** music library can be built directly into one of the music workstations **(500)** to be a master, with the other workstations being slaves, that can either include the processor subsystem and non-volatile storage or can be lower cost dummy slave terminals. As illustrated in FIG. **6**, a first master workstation **(300)** provides a basic workstation subsystem **(200)** plus contains the processor subsystem **(280)** and non-volatile storage system **(285)** as a part thereof so as to provide a complete stand alone music communication system, and be capable of acting as a master or master/slave. This master workstation(s) **(300)** can function as a stand alone, or can couple to one or more other

workstations, including one or more masters (**300**) and/or one or more non-master workstations (**105**).

The multiple connected workstations can operate as stand alone workstations using their local intelligence for displaying downloaded or resident music compositions. They can also interact in a master/slave linked environment, where one of the master workstations (**300**) asserts a master status, and all other inter-connected workstations, whether workstations (**105**) or master/slave workstations (**300**) operate in a slave mode coupled to independent on the designated master. Additionally, masters can communicate between each other for a master/master network configuration.

Alternatively, the multiple connected workstations can operate together in a networked virtual performance mode, or in a networked communications mode. A dedicated stand alone or distributed master workstation architecture can provide for the coordination and combination and synchronization of the multiple individual performance data outputs into a combined virtual performance data output.

Referring to FIG. **7**, an alternate embodiment of the present invention is provided where one or more workstations (**105**) include, at a minimum, a display of the music notation. These workstations are coupled to a master music communications controller (**415**) that provides for a separate user input (**411**) which provides input interface, such as to a MIDI status stream, computer data links (such as RS232, modem data link) etc. that designate requested musical compositions, transformations, and display requests for various ones of the coupled workstations.

In an alternative embodiment, the master music communications controller **415** provides for additional functionality including virtual performance mode, wherein the input interface (such as the MIDI stream, computer data links, etc.) provide one or more of musical compositions data for display, transformation information, display requests, user individual performance data, and wherein the workstations respond to the master music communications controller to couple their individual performance data and receive back the combined virtual performance data.

The workstations (**105**) access the music database storage means (**420**) that provides the data for the requested music composition via the master controller (**415**). The master controller (**415**) displays both the requested music composition as well as user interface communication for the music communication system to be displayed on either a dedicated display (**416**) or on one of the workstations (**105**) as designated by the master controller (**415**). The music database (**420**) can either be local, or can be via a data link (e.g., phone line, RF, otherwise). In one embodiment, a motion sensor subsystem (**422**) monitors motion of a target person and responds in accordance with predefined movement interpretation characteristics parameters, such as for a conductor.

In a preferred embodiment, the user input means (**411**) is comprised of a key switch device, such as a touch membrane keypad or capacitance touch surface. Alternatively, in one preferred embodiment, the user input is provided via a touch screen technology. Touch screen technology permits the display of user interactive icons and legends including text and graphics making possible unlimited customization of user input structure according to task needs. Thus, specific switches or sequences of touches to the touch screen can be associated with common use icons from the task being performed in conjunction with words to provide ultimate clarity. User error is virtually eliminated, with the aid of automatic entry error detection, such as defined fields, mandatory fields, etc.

Alternatively, the microphone input (**527**) can provide for coupling of user speech to a processor sub-system (**580**) that uses any of a number of commercially available and well known speech recognition algorithms. These algorithms provide for speech recognition input control, either solely or as a supplement to touch screen or other tactile input mechanisms.

In a deluxe embodiment, an output (**421**) is provided that permits coupling of an external display, such as a color monitor, projection unit, or other display presentation system including one or more of audio, visual, and audiovisual.

Additionally, the display presentation output of the workstation can provide for an audio output presentation of the musical performance, either generated by the work station responsive to the music composition data, to the users performance, to the combined virtual performance data, or responsive to an external source. Additionally, a visual or audio visual presentation can be provided to provide information feedback to the user on both their individual performance as well as from and between individual workstations and/or the master controller or conductor workstation.

In accordance with another aspect of the present invention, means are provided for moving through the printed (displayed) notation of the music in synchronization with the live performance from the displayed musical notation.

Musical notation is used, in the generic sense, to refer to any way of conveying musical performance instructions including but not limited to common musical notation with staffs, notes, sharps, flats, and clefs, extending to written instructions in text form to supplement this or supplant or partially replace, as well as alternate forms of expression such as chord charts, words and chords (letters), tablature, any video, graphic, audio, audiovisual or other display presentation or combination of the aforementioned types of presentations.

An annoyance in performing music using any written notation (whether on paper or displayed on a presentation apparatus such as a screen) is smoothly performing music and timing "flips of pages" (or the communication of change to a third party, such as touching a key or button). This is especially true when the user is marching and both hands are required simultaneously.

In accordance with one aspect of the present invention, means are provided to accept inputs from one or more sources that initiates a "page turn". Types of inputs include conventional touch input apparatus (such as key switches or capacitive touch pads), motion sensing gear, and automatically when operating in the operational mode of Auto Mode. The motion sensing gear can be for a portion of the performer's body, such as a head tilt sensor or an optical eye movement sensor, etc.

Additional types of inputs that can initiate a "page turn" include voice or sound recognition apparatus built into the microcontroller system. This apparatus has the ability to use pattern recognition specific to the sound or user voice and words being said (for extremely high accuracy). Of course, any type of user actuated device such as a foot or hand switch, or head motion device, or sound or voice recognition system, in a preferred embodiment, is selectively permitted to control the override of the normal progression of the music's play.

The override may cause the progression to go backwards or forwards in the music score irrespective of the normal reading of it. The performance mode AutoMode blocks the user override to permit performance according to proper

material timing and either progresses responsive to the music composition data timing, or in an optional embodiment, to the performer. This automatically moves through the musical score as written and preferably shows an indication of metronome time and an indication of the proper place in the score where the performer should be for that instrument at any specific time. This is especially valuable in a conductor mode of networked communication, where a conductor couples to one or more music workstations.

The user's performance can be compared to the score, and feedback can be provided to the performer as to the quality of their performance.

In the performance monitor mode, for a single user or multiple users, the user (or a remote teacher or conductor) can indicate the rate at which he feels the performer should be performing. A microphone input on the music workstation samples the user's actual performance and permits providing a graphical mapping (for the user or teacher/conductor) showing the relative synchronization of the performer's actual performance versus the conductor's desired performance.

In an alternate automatic advanced mode, the display of the music composition is synchronized to the performers actual performance. Thus, rather than simply indicating visually for the teacher/conductor or user what their relative performance was to the written displayed musical composition, the relative performer to written music synchronization information can be utilized to adjust the display rate of the actual musical composition to match that of the performer.

With use of appropriate sound baffling, a plurality of instruments can simultaneously be monitored and controlled by the conductor, so long as each instrument's output sound pattern is communicated directly to a respective workstation. The output of each of the workstations can then be coupled to the conductor's master workstation for further analysis and processing.

A workstation for an oboe may have a built in slide boom with a featherweight microphone to be able to receive sound input from the oboe. Electric instruments, such as guitars, keyboards, and other electrical analog signal sources can be fed directly to a line input that is appropriately buffered and filtered. Signal input can also be accommodated through a MDI-interface sub-system that permits both utilization of data in workstation to workstation communications and utilization of MIDI-output at the station where the data was input.

For networked virtual performance, and for one aspect of output display presentation, the utilization of MIDI input and MIDI output, at each of the individual workstations and at the master controller workstation, permits the capture of the user performance and conversion to individual performance data which includes time synchronization information which can be communicated to the master workstation, which synchronizes and combines the individual performance data to generate combined virtual performance data which is then communicated back to the individual workstations which utilizing their MIDI output interfaces provide for display presentation (e.g. audio output) of the combined virtual performance data. Additionally, even where virtual performance mode is not selected, the provision of MIDI interface input and output on the workstations have other multiple beneficial users as discussed elsewhere herein. Additionally, other types of user performance to user performance data input devices and transducers can be utilized, as are well known commercially available including variations of analog digital converter input devices, audio signal capture, etc.

By combining the conductor and performance mode operations, the workstation can be enhanced to provide training and comparison of performance to actual music.

Some music is only available in anotated forms where there is not an existing signal showing proper synchronization of the signals. Thus, a controller subsystem (such as **(580)**) provides for real time conversion and analysis of syntax of the music notation, in conjunction with a precision clock metronome, and provides an indicator (such as color or other highlighting or bolding or accentuating) of the relative timing of the performance relative to a place in the sheet music (or other form of musical notation).

Existing forms of music notation can be converted manually, or can be converted automatically by scanning in sheet music, recognizing (using optical character recognition) the various elements of the music, and facets and specifics of the syntax in the form of notation including its constants and variables and protocols, and integrating via an artificial intelligence type expert system that notates, highlights, and accentuates via synchronized metronoming of time signature to music. Any of a variety of other means of converting music can also be used, such as direct input of musical performance signals processed via software that converts it into musical notation. Such software is commercially available, such as from ARS NOVA, Wildcat Canyon Software, Mark of the Unicorn, Inc., and Passport Designs, Inc.

Since the music notation is now in computer usable form, it is now an easy task to communicate, display, compose, alter, and transpose music (such as in key, for types of instruments or voice parts, and harmonies) via well-known techniques.

Additionally, where the user input is converted into user performance data for the workstation, the users individual performance data is also now in computer usable form and if appropriately converted from performance to performance data, includes appropriate synchronization data relative to master controller performance synchronization signal. Thus, both the music notation is in computer usable form (making it easy to display, alter and analyze/compare), and the users performance is in computer usable form (digital individual performance data), it is possible to provide intelligent operation and analysis and utilization of both the music composition information and the user performance information, to provide for various automated modes and features to the users Implementation can also be in a custom design comprised of a microprocessor, non-volatile storage memory, read/write memory, and whatever additional peripheral circuitry is needed (such as are available in ASICs, or single chip micro-computer chip sets including CPUs, DSPs, A/D, and other peripheral support circuitry). These single or multiple chip solutions can be utilized to create a dedicated system to perform complete music workstations performance criteria to support an extremely low cost, high volume music workstation solution.

A new form of communication is created in that both the process of communicating via standard notation is respected and adhered to, while at the same time permitting interaction and communication of music media signals ranging from simple analog, digitized (analog to digital converted), individual performance data (representative of the user's performance), and can optionally include timing/synchronization data.

A multi CD ROM changer accommodates indexed storage of hundreds of thousands to millions of musical compositions to permit complete stand alone operation of the user music workstation. Alternatively, an optional built-in or external modem can be provided to permit intercommunication with a remote central music database management system that permits both communication and down loading (and disconnect) for stand alone operation. Thus the workstation can stay on-line, pulling up music as needed, or can request a single or multiple pieces of musical works be provided to it, that are then down-loaded from the central database manager. The user workstation then disconnects from the music database management system, and thereafter operates stand alone where all desired music is stored locally in storage (preferably non-volatile). Storage can be semiconductor, magnetic, optical or any other medium.

The use of virtual reality technology, including motion sensors and body gloves, permits monitoring of various other things (as shown in FIG. **9**). For example, as shown in FIG. **10**, a camera in conjunction with analysis logic, such as expert software, can monitor motion of role model behavior and compare performer behavior. Hand, finger, arm, leg, eye, head, body, and mouth movements can all be monitored and constructive critical feedback can be accumulated, analyzed, and fed back to the user or teacher, for performer training, or performances, or for conductor communication.

The input of monitored movement data is provided to the user workstation, permitting precise mechanics training such as finger position, the angle of striking of strings relative to the neck of a violin or guitar, or they can be used to permit the virtual performance of music by a performer using a virtual link apparatus such as a virtual reality glove and head movement detection apparatus. The user can then perform a piece with their own personalization without any musical instrument in fact.

For example, the guitar portion for a piece of music could be displayed in notation form and actually performed according to the timing of movements of the user's fingers (either actual fret positions, or only timing information). To add further reality, a mock guitar, keyboard, flute, or other instrument can be used and combined with virtual effects to provide for music performance and personalization. Thus, for entertainment purposes, users could perform as part of a symphony orchestra playing a violin portion. If they performed out of time, they would hear their instrument's performance out of synch with the rest of the orchestra's performance.

There are numerous ways to embody the conductor movement interpretation system. As illustrated in FIGS. **9** and **10**, one is utilizing the body movement detection apparatus prevalent in virtual reality, sports medicine, etc., as discussed above, to identify specific movement patterns or signal parameters associated with certain movement patterns, to initiate a display presentation, audio, video, or audiovisual to provide a presentation associated with movement of the conductor. Alternatively, other techniques can be used such as taking the video feed from a video camera or other video source (e.g. VCR) and having the conductor interpret his movements and assign them unique meanings, to create a lexicon of his movements and corresponding meaning.

For example, rapid downward movements of the hand from up to down, in a certain manner, indicate "decrease the volume." When he points at a particular section at the same time as he is doing that, he is indicating that only that orchestra section is to reduce volume. In this manner, either camera input of movements, glove sensing of movements, or other techniques (such as audio, ultrasonic, etc.) can be used to track movement to permit associated meanings to be attached or indexed to particular signal parameters or parametric signals of the meaning of the movement parameters as provided by the conductor input device. For example, in the case of the virtual reality glove, that input would be the signal output of the glove as interpreted by associated software in a processor (such as a PC or a MAC). Alternatively, for example, in the case of video camera input, it could be pattern recognition or analog signal comparison to determine the presence of certain signal patterns indicating to the system to initiate automatic communication of a conductor presentation. In so doing, the conductor is able to rapidly convey his meaning, focus it to a particular group of instruments, and be done with it. He doesn't have to focus very long or concentrate to make sure they've gotten his signal. Instead he can focus on listening to see if they got his message.

FIG. **8** illustrates an alternate embodiment of the present invention. In this embodiment, the workstations are remote units (**801–803**) used by a member of a marching band. Each of the remote units (**801–803**) are equipped with receivers (**810–812**) that receive musical compositions transmitted to them. Remote units controllers (**820–822**) control the operation of the remote unit (**801–803**). The musical composition is displayed on the remote unit's displays (**830–832**) which displays can be an LCD multiple line display providing low cost, low power usage, and high visibility/readability, and with Auto Advance Mode, the display automatically scrolls as the music is to be performed.

Each remote unit (**801–803**) can be mounted on the instrument on or in place of the lyre. The remote unit's antenna (**840–842**) can be separate from or built into the remote unit or the lyre.

A transportable main unit (**850**) is used to transmit musical compositions to the remote units (**801–803**). The transportable main unit (**850**) is comprised of a controller (**806**) for controlling the transportable main unit (**850**), a music database storage medium (**805**) containing the data for the musical compositions to be played by the band, and a transmitter (**804**) for transmitting the musical compositions to the remote units (**801–803**). This main unit can be in the form of a suitcase or briefcase size item. The main unit can also be provided built into a van that is driven around with the band or as a small self-contained portable unit. In accordance with this embodiment, the band can play a virtually unlimited number of musical compositions without the problem of carrying the music with them in paper form. It also relieves the band members of the problems of changing music and changing pages while marching. As discussed in the above embodiments, in the performance mode, the musical score is automatically scrolled across the screen display (**830–832**). Additionally, a keyboard and/or microphone can be attached to the transportable main unit allowing the conductor to send messages to the remote units via displays (**830–832**) or via a speaker associated with units (**801–803**). This allows the conductor to send instructions to the band (such as to take a certain route, or play at different volumes or speeds). With bidirectional communications and user performance feedback, the conductor can also monitor for errors.

FIG. **9** illustrates a conductor, stage hand, or other person with a sensor glove on each hand (**935**) and a head and eye movement monitor (**930**). The figure also illustrates the conductor wearing full body sensor equipment (**940**). Either

embodiment or a combined embodiment can be used to map body movements. If only the gloves (**935**) or body sensors (**944**) are used, the movement of the glove or sensors can be captured by a video system, as illustrated in FIG. **10**.

Other methods that capture motion rely on specialized sensors (**944**) placed on a performer's joints, such as via a sensor body suit (**940**). Once motion has been filmed or analyzed, a data set is produced to interpret that movement into Cartesian co-ordinates. These co-ordinates provide the spatial location of each of those markers. This information is then cleaned up and input to an animation package.

FIG. **10** illustrates a video camera (**1005**) and a standing conductor (**1015**) (or performing musician to be tracked or virtually linked to perform), with or without a blue screen (**1010**) behind him. The video camera (**1005**) feeds a video signal to the video processing system (**1020**) that utilizes signal processing to provide signal pattern recognition capability. The blue in the screen is filtered out in the signal processing such as by an Ultimatte process.

In one embodiment, the conductor is wearing a sensor equipped body suit (**940**) and gloves (**935**) of FIG. **9**. In another embodiment, the conductor is wearing only the sensor equipped gloves (**935**) of FIG. **9**. In still another embodiment, the conductor's movements are picked up by the video camera (**1005**) and processed without a sensor suit.

Simple things, like looking for the conductor's rapid hand movements, focusing on specific hand movement areas, facial and head movement, arm movements, and body language can all be programmed into the recognition knowledge base. Some of the technology for complete mapping of body movement that exists in making video games of today are illustrated in *Video Systems* magazine, page 42, October 1995, Vol. 21, No. 11, and NEXT Generation magazine, pages 49–54, October 1995, both incorporated herein by reference.

In any event, having now obtained knowledge related to recognition of the movements, the system can interpret them and utilize them to convey presentation information to the ensemble or orchestra or studio members, or to analyze a performer's movements, or to permit a virtual performance. One example would be a large screen television or multiple large screen televisions for viewing by the members of the viewing group. Alternatively, each music stand could provide for a picture in picture display of special movements of the conductor in areas of the display where music is not currently being played. Since the stand can have the intelligence to compare the performed music to the played music, that embodiment permits display of the message in portions of the music display area which have already been performed or are not going to be performed for some time (e.g., at least ten seconds in either direction; other criteria could alternatively be used, and can be set up for desired characteristics of the performing environment).

Voice recognition and response to conductor commentary can supplement the system. The system could record the message, interpret to whom the conductor directed the message and convey it audibly or translate it into a text or icon display as a part of the system's audiovisual presentation.

Referring to FIG. **11A**, an alternative embodiment of the automated mode "A Mode" (**240**) of FIG. **2C** is illustrated. The illustrated process for the automated Mode **240** of FIG. **11A** includes process steps for the Auto Advance A Mode 1, Training A Mode 2, Performance Mode A Mode 3 which are equivalent to the illustrated A Modes 1, 2, and 3 of FIG. **2C**. However, as shown in FIG. **11A**, at step **1148**, the decision is made whether the conductor automated mode is selected, and if a "yes" decision, then automated Mode 4 is entered at Step **1149**, and if a "no" decision, then logic goes to the networked virtual performance mode A Mode 5, as decided at decision logic step **1150**, and responsive to the selection of the networked virtual performance mode, A Mode 5 (**1151**) is executed. If networked mode A Mode 5 is not selected, then processing proceeds to decision logic step **1152** to decide whether the synchronization of the display to the performance (Mode A 6) has been selected, and if so, then the processing proceeds at step **1153** to provide A Mode 6 functions. The automated mode processing ends at step **1154**. It is to be noted that the automated modes can be cumulatively selected, so that the networked virtual performance can include any or all of the other automated modes, including A Modes 1, 2, 3, 4, 5, and 6, or other A Modes which may be provided. It should also be noted that the tracking of the performance by the user relative to the presentation of the musical composition (step **272** of FIG. **2D**) provides the first part of the logic necessary for the A Mode 6 (synchronization of display to performance), as illustrated in FIG. **13** in further detail.

Referring to FIG. **11B**, there is illustrated an alternative overall operation of a music composition communications system, alternative to that illustrated in FIG. **2A**, showing additional automated modes including the network virtual performance mode A 5. FIG. **11B** illustrates an alternative control logic structure for the network selection, where the decision logic proceeds in an analogous manner to FIG. **2A**. The operation starts at step **1100**, and a mode is selected at step **1110**. A composition is selected at **1120**, and if the decision logic **1120** determines the composition has been selected, then processing proceeds at step **1130**, which provides for selection of the mode. If no composition has been selected, processing proceeds back to the select composition step **1110**. Once the composition has been selected, then a Mode is selected as illustrated at step **1130**, and the decision logic of select Mode **1140** determines whether the selected mode is that of (1) a display mode, in which case processing proceeds to step **220** of FIG. **2A**, (2) a modified composition mode, in which case processing proceeds as from step **215** of FIG. **2A** going to the yes branch, or (3) the select mode determines that the networked virtual performance mode has been selected, in which case processing proceeds to the networked mode automated Mode 5, step **1150**, as illustrated in further detail in FIG. **12**.

Referring to FIG. **12**, there is illustrated the networked virtual performance process flow, step **1150** of FIG. **11B**, in greater detail. At step **1150**, the automated mode of networked virtual performance has been selected. This automated mode 5 is processed by proceeding to verify the selection of the composition. At step **1220**, the user's performance is captured (e.g., by a microphone or via MDI) and converted to individual workstation performance data. This data is then broadcast by each of the plurality of individual music stands to a designated master controller. At step **1230**, the controller receives and combines the plurality user's individual performance data to generate a combined performance data representative of the synchronized and combined plurality of individual performance data This combined performance data is then broadcast to all of the individual music workstations. At step **1240**, each of the plurality of individual music workstations provides an output (e.g., audio) responsive to the combined performance data, which is representative of the combination of the plurality of users audio performances of the music composition, synchronized to the display presentation of the

music composition. Timing synchronization data is provided to synchronize the plurality of individual music workstations individual performance data to one another and to the selected musical composition's display presentation, to facilitate synchronization for purposes of combination and audio playback at the individual workstations, in approximately real time, so as to provide apparent real time feedback of the individual user's performance in combination with all other individual users, played back at each of the individual workstations. At step **1250**, analysis is done as to whether the composition is done. If so, processing completes at step **1260** and ends this automated Mode 5. Otherwise, if processing is not done, that is the musical composition is not over, then processing proceeds back to step **1220** as illustrated.

Referring to FIG. **13**, there is illustrated automated Mode 6 corresponding to synchronizing the actual display presentation to the user's performance, providing resynchronization of the display of the music to account for the actual performer's timing, and any errors or differences. Automated Mode 6 is analogous to A Mode 1 without override, but not to A Mode 3, which auto-advances independent of the user's performance. At step **1153**, the automated modes 6 is entered. At step **1310**, analogous to step **272** in FIG. 2D, the user's performance is tracked and stored for comparison to the musical composition display presentation relative to the timing of where the performance should be. At step **1320**, the performance that has been tracked is compared to the score and deviation performance data for that performer is generated. At step **1330**, the errors are utilized to resynchronize the display presentation of the musical composition to adjust to the actual user's real time performance timing relative to the display presentation and a synchronization of the commencement of the user's performance relative to the musical composition's presentation on the display. At step **1340**, an analysis is done as to whether processing is complete (e.g. is the musical composition done?). If so, A Mode 6 ends at processing step **1350**, and either the automated modes of processing can end, or other automated modes can be checked for, and processing can begin for another selected automated mode.

Referring to FIG. **14**, there is illustrated the communications architecture and system in accordance with the present invention, wherein there are a plurality of individual music workstations **1410**, each responsive to a user's performance of a musical input (**1411**) which is processed by the individual music workstation **1410** to provide a performance data output **1412** coupled for communication to a control system **1450**, which can be a master controller or master workstation, which is coupled for receiving and processing the individual workstation performance data for the plurality of individual workstations. A communications interface **1413**, such as a modem, can provide for coupling and communication between the individual workstation **1410** and the master controller **1450**. In one embodiment, the modems **1413** are coupled via a public switched telephone network to a corresponding modem **1455** which couples to the master workstation to communicate by directionally between the individual workstations and the master workstation. Alternatively, any sort of cable, hardwired, or wireless communications interface and provided, and would work equally well when in accordance with the present invention. The master controller **1450** is responsive to the individual performance data outputs from the plurality of individual workstations to provide a combined and synchronized virtual performance data output **1451** which is coupled via the communications network to the plurality of individual workstations, which each then respectively provide an output (e.g. audio) **1415** for presentation to the user, representative of the combined performance data. An audio and/or visual presentation output **1452** can also be provided at the master workstation.

Referring to FIG. **15**, there is illustrated the data flow and communication architecture for one embodiment of the present invention. A music communication system is provided that has a plurality of physically separate remotely located locations, each having one or more individual music workstations, wherein each of the individual music workstations provides for communication output of individual performance data for a user's performance of a displayed musical composition at that individual workstation. As illustrated, a master controller **1505** is coupled to the communications infrastructure **1510** at a first location. A plurality of individual music workstations **1511**, **1512**, **1513**, and **1514** are coupled to the communications infrastructure **1510** at location 1, designated performance group 1. Similarly, location 2, performance group 2, provides individual workstations **1521** and **1522** coupled to the communications infrastructure **1510**, and location 3, performance 3, provides individual music workstation **1531**, **1532**, and **1533** coupled to the communications infrastructure **1510**. The plurality of individual workstations **1511**, **1514**, **1421–1522** and **1531–1533**, each provide individual performance data, providing multiple discrete time samples of performance data (e.g. time, segments of data), which can include synchronization information therein, which are communicated via the communication infrastructure **1510** to the controller or master workstation **1505** The resultant output (e.g. audio) from the individual workstations is the resynchronized combined performance data of the plurality of individual performance data, resynchronized for each of the time segments of output.

Referring to FIG. **16**, the data word structure for one embodiment of the present invention is illustrated. The data structure for the individual user performance data is illustrated as comprising a header comprised of control information including a start of word, cyclic redundancy code (CRC) word, the performer's ID (a unique address for the individual workstation, (which not only can provide an unique ID but can also provide for indication of an instrument type), and other control information for other modes of operation in addition to the virtual performance), payload data representing the actual performance data, and timing synchronization data. Any other data word structure providing for header information including control information, and payload information including performance data, and some timing synchronization scheme, whether or not part of the user performance data word will work equally well with the present invention.

FIG. **17** illustrates a networked system embodiment in block diagram form, illustrating the network interface subsystem and music data processor subsystems for one embodiment of the present invention, compatible with the architecture as described in FIGS. **1–15**. FIG. **17** illustrates a single individual workstation **1710**, although a plurality of individual workstations **1710** are usually involved in the networked system (analogous to the plurality of individual workstations **1410** of FIG. **14**). The individual workstation **1710** provides for communication with a master workstation **1790**, (analogous to the communication architecture with the master workstation **1450** of FIG. **14**). The musical performance by the user (**1712**) is coupled to an input interface **1715** which provides musical performance data to a musical data processor **1720**, which can be a MIDI based processor,

which provides the music processed performance data output to a network communications interface **1730** which outputs the individual musical performance data **1731** for coupling via the communications infrastructure to the master workstation **1790**.

The master workstation **1790** processes the individual musical performance data **1731**, from the plurality of individual workstations **1710**, and provides an output **1791** of combined virtual performance data, wherein both the individual musical performance data and the combined virtual performance data are comprised of a plurality of discrete time segmented data samples, wherein the combined virtual performance data is synchronized within each sample time to provide for synchronized combination of the individual musical performance for that time segment

A network interface subsystem **1735** is responsive to the combined virtual performance data to provide synchronized virtual performance data output to the music data processor **1725** (e.g. MIDI) which provides a sound output of the combined virtual performance data corresponding to the synchronized combination of the individual musical performance data from a plurality of the individual workstations **1710**. Additionally, the individual workstation **1710** provides data analysis and presentation processing **1740** which provides an output responsive to, inter alia, the combined virtual performance data to a presentation means such as an audiovisual display, or a video display or an audio output, **1745**. Note that in a preferred embodiment, the multiple individual network workstations **1710** are synchronized (e.g. responsive to synchronization signal from the master workstation **1790**), so that the plurality of the individual workstations simultaneously commence display presentation of the musical composition for synchronization of individual user performances. In one embodiment, the output of the individual performance data (such as via a MIDI music processor) is comprised of timing synchronization information that is used by the master workstation to synchronize all of the musical performances representative individual musical performance data to virtually perform together in a combined and time-synchronized performance. The combined virtual performance data representing the synchronized virtual performance is then sent back (e.g. broadcast) to the individual workstations, coupled via the network communication interface **1735** back to the individual workstation's music data processor **1725**, to provide audio and/or visual output corresponding thereto. Where the master workstation is for a conductor or teacher, the conductor mode or teacher mode can also be utilized in addition to the network virtual performance mod. In fact, all of the automated modes can be selectively combined, such as by providing layering of functions via software.

Referring to FIG. **18**, the timing diagrams for the individual performance data and synchronized virtual performance data is illustrated, relative to signals output from the individual networked workstations NWS_1, NWS_2, NWS_N and a master workstation MWS. As illustrated, the master workstation MWS provides a synch signal to commence synchronization of all workstations (NWS) coupled to the system. In a preferred embodiment, the individual workstations (NWS) begin the display presentation of the musical composition (as does the master workstation) in synchronization with the synch signal from the master workstation. Responsive thereto, each of the individual workstations displays its musical composition, and the users of the workstations can perform the musical composition. Individual workstations (NWS) provide individual performance data responsive to the user's performance. As illustrated, workstation NWS_1 provides performance data A and B at respective times, while in the individual workstation NWS_2 provides individual performance data C & D at respective times, and independent workstation NWS_N provides individual performance data signals E & F at respective times. During the first time segment, individual performance data A, C & E are output, respectively, from individual workstations 1, 2, and N. However, as shown in FIG. **18**, the relative timing of output of the individual performance data (and receipt by the master workstation thereof) are skewed from one another in timing. The master workstation resynchronizes the individual performance data A, C, and E within each time segment, and provides an output of the recombined reconstructed and synchronized A, C, and E to provide synchronized combined virtual performance data. It is to be noted that synchronized virtual performance data A, C, E occurs within the first time segment T1, which contains both the individual performance data and the corresponding responsive synchronized virtual performance data. The maximum time delay T_D represents the acceptable worst case time that a user can tolerate between the user's performance output of corresponding individual performance data and the time until the synchronized virtual performance data corresponding to that individual performance data is received by the same individual workstation and provided as audio output. Similarly, during time slot 2, each of the individual workstations provides individual performance data B, D and F, slightly time skewed from each other, and the master workstation provides combined synchronized virtual performance data B, D, F, which is communicated back to the individual workstations to generate an audio output.

The present invention finds application in many different environments and embodiments. For example, a live practice can be held from multiple locations, while one or more musicians are editing the score and communicating the changes real time, reperforming them, etc. An orchestra can be at one location, while a singer can be at another location. Creating and editing and synchronizing music to movies scores can also be facilitated with the present invention with beneficial gains. For example, in a movie, a lot of elements are changing dynamically that need to be resynchronized. For example, a scene can be lengthened or shortened, and the soundtrack must be adjusted. A score which was created to the movie must be rewritten to accommodate the edited movie. Typically, the composer creates the score at home or at a studio. That score is sent to the movie studio. However, the movie studio may edit the scene that that music is used in, say a reduction of three seconds in the scene. The edited scene is sent back to the composer so that he can shorten his music. The process is slow, inefficient, and an impediment to the production process. By utilizing the present invention, this can be accommodated in real time, and from remote locations, and the virtual performance mode as well as the other modes of the music communication of the present system can be utilized advantageously for this application.

The present system provides an infrastructure for a music Internet. It can be applied to interactive editing of music. It can provide for special one on one mode for teaching and performance evaluation. It can facilitate adapting a music display to the performer's performance, or drive the display to a metronome and force the user's performance to be synched to the metronome timing. Music can be composed, edited, transposed, etc. easily, from any of the plurality of individual workstations or on a single standalone workstation. Multiple individual music workstations (INW's) can communicate with one another, both with data and audio

such as voice and/or music, and/or supplemental data such as video, audio, data files, control signals, applets, etc. Bands can practice at home without the disadvantage of either practicing alone or having to physically get together in a large grouping Singers can group with other instruments and other vocalists via respective ones of a plurality of IMW's, one, two, or even the whole plurality being remotely located physically from one another (e.g., LA, NY).

There can be multiple instruments playing at a single location. There are many options regarding how IMW's are allocatable, such as. (1) on IMW (Individual Music Workstation) per location, (2) IMW per instrument type, (3) one IMW per performer (e.g. Instrument, vocal). There are also many options (1) for networked communications between the IMW's and/or between the IMW's and the Master Workstation. Modes can be selectively mixed and matched and combined, such as (1) all auto-modes enabled mode (2) virtual performance mode, full audio-visual, (3) audio link only mode, etc. There are also many options as to modes of signal processing which can be applied to the user input to generate the individual performance data, ranging from simple analog to digital (A/D), to complex musical sound analysis algorithms (e.g. to detect characteristics such as instrument type, pitch tone, attack, decay, amplitude, voice signatures, etc.) There are also tremendous numbers/ parameters of performance analysis algorithms that can be selected and which utilize the selected musical composition data (corresponding to that displayed on the IMW which is receiving the performance input for analysis) (e.g. the sound characteristics generated by the sound analysis of the user's performance, to (3) in between "(1)" and "(2)". Additionally, many kinds of data can be communicated between (1) IMW's (2) IMW's and a Master Workstation, and (3) IMW's and external communication interfaces, etc. Examples of the kinds of data include performance data, video data, processed/analyzed performance data, audio signals, data files, etc.

Referring to FIG. 19, the memory work space structure for both the individual and the master workstations, in the virtual performance mode, is illustrated. Each of the individual workstations provides for music data buffering o the outgoing live performance data, individual performance data IPDXXX, and further provides for storage of the incoming combined virtual performance data CPDXXX. This buffering is done within read-write memory within the individual IMW's. Similarly, the data structure for the memory buffer of the master workstation is illustrated, showing separate buffer storage locations for each of the plurality of individual workstations WS_1 to WS_N, providing storage of associated respective individual performance data IPD A-N. In one embodiment, multiple frame buffers are provided in the IMS, so that multiple time segments of IPD and CPD data can be stored in the buffer structure, and so that the buffer structure can support both input storage and output retrieval operations. Other data structures and buffering operations are also compatible with the present invention. The structure of the data word can be changed or adapted within its existing structure to facilitate the transfer of supplemental data is transferred from the IMS or Master Workstation, or between the IMW's, or between the IMS's and the Master Workstation. By utilizing the illustrated or other compatible data buffer structure, timing and synchronized (with the frame buffered variety) asynchronous communication are facilitated, not only as between communication workstations, but furthermore, as to the operations internally of the IMW. With frame buffering, the individual workstation and master workstation can dump the result output to the buffer, or receive input individual performance data asynchronously and buffered, relative to the other operations of the respective workstation, The IMW can facilitate operation in one mode or in multiple modes concurrently.

From the foregoing, it will be observed that numerous variations and modifications may be effected without departing from the spirit and scope of the invention. It is to be understood that no limitation with respect to the specific apparatus illustrated herein is intended or should be inferred. It is, of course, intended to cover by the appended claims all such modifications as fall within the scope of the claims.

What is claimed is:

1. A music workstation system for use by a user in providing a performance of a displayed video display presentation of a selected musical composition, said system comprising:

storage means for storing composition data representative of the selected musical composition;

display means for displaying the video display presentation responsive to the composition data;

input means, responsive to the performance by the user, for providing user performance data output;

analysis means for comparing the user performance data to the respective associated composition data; and

control means for modifying the display of the composition data responsive to the analysis means.

2. The system as in claim 1, wherein the modifying is comprised of resynchronizing the fixed rate to resynchronize the display of the composition data to the performance by the user responsive to the analysis means.

3. The system as in claim 1, wherein the modifying is comprised of displaying performance variance data responsive to the analysis means.

4. The system as in claim 1, wherein the workstation system is further comprised of means for modifying the sequencing and timing of the display presentation responsive to input from the users.

5. The system as in claim 4 wherein the composition data is comprised of timing information data and wherein the sequencing and timing of the display presentation is controlled responsive to the timing information data.

6. The music workstation system as in claim 1, wherein the

control means provides for a display presentation of the differences between the displayed composition data and the performance data, responsive to the analysis means.

7. The system as in claim 1 further comprising:

processor means for generating a video display output responsive to the composition data in the storage means for the selected musical composition;

wherein the display means provides the video display presentation responsive to the video display output;

wherein the input means is further comprised of storage for storing user performance data concurrent with the corresponding display presentation; and

wherein the control means modifies the video display presentation to reflect the result of the comparing the user performance, data, and the composition data.

8. The system as in claim 1, wherein the user performance data is comprised of at least one of audible performance data, visual performance data, and control data.

9. A music display presentation system for use by a user in viewing a selected musical composition, said system comprising:

a workstation apparatus, comprising:

storage means for storing musical composition data representative of musical notation and display presentation corresponding thereto;

display means for providing a display presentation responsive to the musical composition data;

means for progressing the display presentation responsive to the musical composition data;

mode controller means for managing the operation of the workstation in at least one selected automated operational mode to provide for automated progression of the display presentation of the musical composition;

wherein the selected automatic operational mode is comprised of at least one of marching band mode, conductor mode, orchestra mode and networked virtual performance mode.

10. The system as in claim **9** further comprising:

input means, for providing an output of user performance data responsive to performance by the user

analysis means for analyzing at least one of the user performance data, the musical composition data, and

control means for providing an output of individual workstation data responsive to the analysis means.

11. The system as in claim **9** wherein the musical composition data is further comprised of temporal data,

wherein the display presentation is logically sequenced responsive to the temporal data.

12. The system as in claim **9**, wherein the workstation provides user instrument type data, wherein the mode controller manages selection of the transposition responsive to the user instrument type data responsive to the user instrument type data.

13. The system as in claim **12** wherein the user instrument type data is determined responsive to at least one of a live performance by the user, a performance by the user and a user input selection.

14. The system as in claim **12**, wherein the user instrument type data is representative of at least one of voice, musical instrument by type and electronically generated.

15. The system as in claim **9**, wherein the workstation is operable in a plurality of operational modes concurrently.

16. The system as in claim **9** wherein the workstation is coupled for communication with at least one other one of the workstations to form a network of workstations.

17. The system as in claim **16** wherein one of the workstations in the network functions as a master controller and collects and stores the individual workstation performance data from the plurality of workstations coupled in the network.

18. The system as in claim **17** wherein the master controller processes the stored individual workstation performance data to provide an output of combined stored performance data to all the workstations.

19. The system as in claim **18**, wherein the plurality of workstations in the network are synchronized to each commence the display presentation at approximately the same time.

20. The system as in claim **19**, wherein the individual workstation performance data for the plurality of workstation are synchronized and combined to provide the combined performance data.

21. A virtual music performance system for use by a plurality of users in providing a plurality of display presentations of a selected musical composition, said system comprising:

a plurality of individual music workstation (IMW), each IMW comprising

a communication interface providing for communications of musical composition data of the selected musical composition with the respective IMW;

a computing subsystem providing processing and memory for locally storing the musical composition data responsive to the communications interface; and

a music display apparatus for providing a local visual display presentation of the selected musical composition responsive to the computing subsystem;

wherein the system further comprises means for controlling a plurality of the IMWs to concurrently provide a plurality of local display presentations of the selected musical composition.

22. The system as in claim **21**, further comprising:

an input device responsive to a performance by the user of the displayed musical composition for providing an output of user performance data.

23. The system as in claim **22**, wherein the computing subsystem provides processing means responsive to said user performance data for providing an output of individual performance data out.

24. A musical data communication system enables a presentation of a selected musical composition for use by a plurality of users, said system comprising:

a plurality of individual workstations each providing means for independently capturing the musical performance of a respective user and communicating individual performance data;

control means for synchronizing and combining the individual performance data from the individual workstations to provide an output of combined performance data;

means for communicating said combined performance data to the plurality of individual workstations;

wherein at least one of the individual workstations provide at least one of an audio, video, and audiovisual output representative of the combined musical performances for all of the communicating plurality of individual workstations.

25. The system as in claim **24** wherein the plurality of individual workstations provide for synchronized display presentation.

26. The system as in claim **25**, wherein each of the individual workstations provide for output of individual performance data representative of the musical performance by the user corresponding to the display presentation.

27. The system as in claim **25** wherein the individual performance data is further comprised of timing synchronization data.

28. The system as in claim **26** wherein the control means provides a synchronization signal, wherein the individual workstations provide said timing synchronization data responsive to the synchronization signal.

29. The system as in claim **24** wherein each of the individual workstations is further comprised of a network interface subsystem and a music data processor.

30. The system as in claim **24**, wherein a plurality of the individual workstations provide at least one of an audio, video, and audiovisual output representative of the combined musical performance.

31. A musical display system comprising:

a memory, for selectively storing musical composition data representative of a selected musical composition;

means for producing a display presentation responsive to the respective musical composition data;

selection means for determining a selected display format;

data processing means responsive to the selection means for selectively processing the stored musical composition data responsive to the selected display format to produce a corresponding particular display presentation format responsive to the musical composition data; and

at least one display subsystem, responsive to the selected music composition data and the selected display format, for displaying a video presentation of the musical composition in the selected display format.

32. The system as in claim **31**, wherein said processing comprises at least one of transposing and communicating external to the musical display system.

33. The system as in claim **29**, further comprising:

operational selection means for determining a selecting operating mode wherein the data processing means is responsive to the selected operating mode for controlling progression of the video presentation.

34. The system as in claim **31**, wherein responsive to the selection of the display format, the data processing means provides for additionally displaying at least one of user fingering and user motions.

35. The system as in claim **31**, wherein the selection of the operating mode provides for selection of the visual advancement of the display presentation as at least one of scrolling of display music notation, page turn, page flip, and page push.

36. The system as in claim **1**, wherein the local presentation is a video display.

37. A communications system comprising:

a plurality of individual music workstations, each comprising a music display apparatus for providing a local visual display presentation of a selected musical composition and a music input for selectively providing a performance data output, responsive to a performance by a user of that respective individual music subsystem;

wherein the system further comprises means, responsive to the performance data output from each of the plurality of individual music workstations, to provide a combined output of composite virtual performance data.

38. The communications system as in claim **37**, wherein the plurality of individual music subsystems each provide means for independently capturing the musical performance of the respective user and generate respective individual performance data;

wherein the means responsive to the performance data is further comprised of means for synchronizing and combining the individual performance data from the plurality of individual music subsystems to generate combined performance data; and

means for communicating said combined performance data to the plurality of individual music subsystems;

wherein at least one of the individual music subsystems provide a local presentation representative of the combined musical performances for all of the communicating plurality of individual music subsystems responsive to the combined performance data.

39. The system as in claim **38** wherein the plurality of individual music subsystems provide for synchronized display presentation of the musical composition.

40. The system as in claim **38**, wherein each of the individual music subsystems provide for output of individual performance data representative of the musical performance by the user corresponding to the display presentation.

41. The system as in claim **38**, wherein the selected musical composition is performed in discrete time segments, wherein the means responsive to the performance data generates a synchronization signal for start of performance, and each of the time segments is synchronized relative to the synchronization signal from the master means responsive to the performance data.

42. The system as in claim **37**, wherein the composite virtual performance data is communicated back to the individual music subsystems.

43. The system as in claim **37** wherein the individual workstations provide at least one of an audio output and a visual presentation, responsive to the composite virtual performance data.

44. The system as in claim **37** wherein each of the individual workstations is further comprised of a network interface subsystem and a music data processor.

45. The system as in claim **37**, wherein the processor is responsive to the composite virtual performance data to generate a presentation on the local display.

46. A method for communication with a source of distribution of musical data representative of a musical score in a computer-usable form to a music workstation for video presentation of musical notation for the respective musical score, the method comprising:

accepting at least a part of the musical data from the source;

evaluating the at least a part of the musical data to determine if the musical data is to be downloaded to the respective music workstation;

selectively storing in local storage the musical data responsive to the evaluating; and

locally displaying a video presentation of the musical score responsive to the selectively stored musical data.

47. The method as in claim **46**, further comprised of:

providing a plurality of separate ones of the music workstations, each of which provides for selectively storing and locally displaying.

48. A method for music via performance, for integrating simultaneous musical performances from a plurality of locations of music display workstations into a cohesive whole, the method comprising:

accepting performance data from each of the plurality of music display workstations;

processing the live performance data into discrete time samples;

communicating the discrete time samples for combination into combined virtual performance data;

communicating the combined virtual performance data to at least one of the plurality of music display workstations; and

providing at least one of an audio and a video presentation responsive to the combined virtual performance data.

49. A method of providing a video display presentation of a selected musical composition and of a user's performance, said method comprising:

storing composition data representative of the selected musical composition;

generating a video display output responsive to the composition data for the selected musical composition;

displaying the video display presentation responsive to the video display output;

storing user performance data concurrent with the corresponding display presentation responsive to the performance by the user;

comparing the user performance data to the respective associated composition data; and

modifying the display presentation to reflect the result of the comparing concurrent with the performance of the composition data.

50. A music performance system for use by a user in providing a performance of a display presentation of a selected musical composition, said system comprising:

an individual music workstation (IMW) comprising

a communication interface providing for communications of musical composition data corresponding to the selected musical composition;

a computing subsystem providing processing and memory for locally storing the musical composition data responsive to the communication interface; and

a music display apparatus for providing a visual display presentation of the selected musical composition responsive to the computing subsystem and the musical composition data.

51. The system as in claim **50**, further comprising:

association means for associating an Instrument Type to the IMW;

control means for broadcasting musical display data for multiple separate graphical display presentations corresponding to multiple separate respective multiple Instrument Types;

wherein the IMW is further comprised of discrimination means for discriminating between the multiple separate graphical presentations to select a specific one representative of the corresponding respective one of the Instrument Types, responsive to the association means and the discrimination means.

52. The system as in claim **51**, further comprising:

a source of secondary video data representative of a secondary video image;

video controller means for displaying the secondary video image as a picture-in-picture within a subpart of the visual display presentation.

53. A communications system comprising:

an individual music subsystem comprising a music input for selectively providing a performance data output, responsive to a performance by a user of that respective individual music subsystem, and a music data receiver for coupling communicated music data for storage in memory of the respective individual music subsystem; and

a display for providing a visual presentation to the user from at least one of the stored music data and the performance data output from the individual music subsystem.

54. The system as in claim **53**, further comprising a plurality of individual music subsystems, the system further comprising:

means to provide a combined output of composite virtual performance data responsive to communicated performance data out from at least two from the plurality of the individual music subsystems.

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